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Peddie et al.

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US007859431B2

(54) **METHODS, SYSTEMS AND DEVICES RELATED TO ROAD MOUNTED INDICATORS FOR PROVIDING VISUAL INDICATIONS TO APPROACHING TRAFFIC**

(75) Inventors: **Timm Peddie**, Capitola, CA (US); **David P. Bim-Merle**, Palo Alto, CA (US); **Thomas A. Burnham**, San Jose, CA (US); **Daniel O. Santos**, Palo Alto, CA (US); **Lawrence E. Miller**, Burlingame, CA (US); **Vineet Mehta**, Sunnyvale, CA (US); **Johannes B. Van Niekerk**, Redwood City, CA (US)

(73) Assignee: **Spot Devices, Inc.**, Sparks, NV (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **12/492,143**

(22) Filed: **Jun. 26, 2009**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 11/055,558, filed on Feb. 10, 2005, now Pat. No. 7,688,222.

(51) **Int. Cl.**
G08B 1/08 (2006.01)

(52) **U.S. Cl.** **340/907**

(58) **Field of Classification Search** .... 340/905, 340/901, 906, 937, 539.1, 539.25, 332, 333; 116/63 P, 1, 63
See application file for complete search history.

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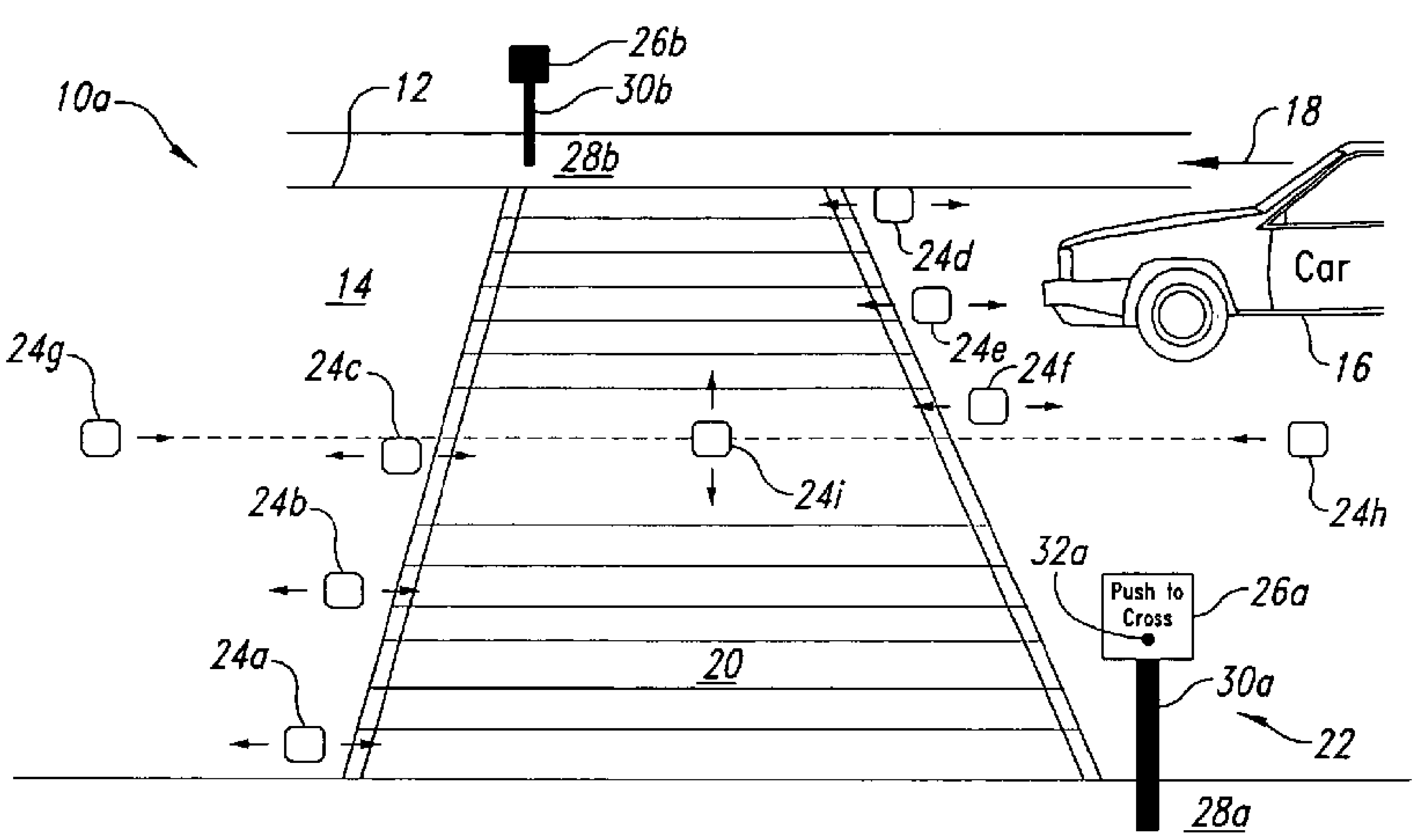
Primary Examiner—Daryl Pope
(74) *Attorney, Agent, or Firm*—Alston & Bird, LLP

(57) **ABSTRACT**

A traffic informational system provides information to traffic moving along a road and may include a plurality of traffic information devices mountable to the road, each having an integral power producing source, at least a first set of illumination sources, and a wireless communications subsystem. The traffic informational system may further include at least a first external control device comprising at least one antenna and a transmitter communication wirelessly with the traffic information devices and/or with one another. The traffic information device may communicate with one another, and may include sensor for sensing ambient conditions. The system employs various approaches to reducing power consumption and improving communications, and is suitable for a wide range of applications, including use in remote environments.

13 Claims, 34 Drawing Sheets



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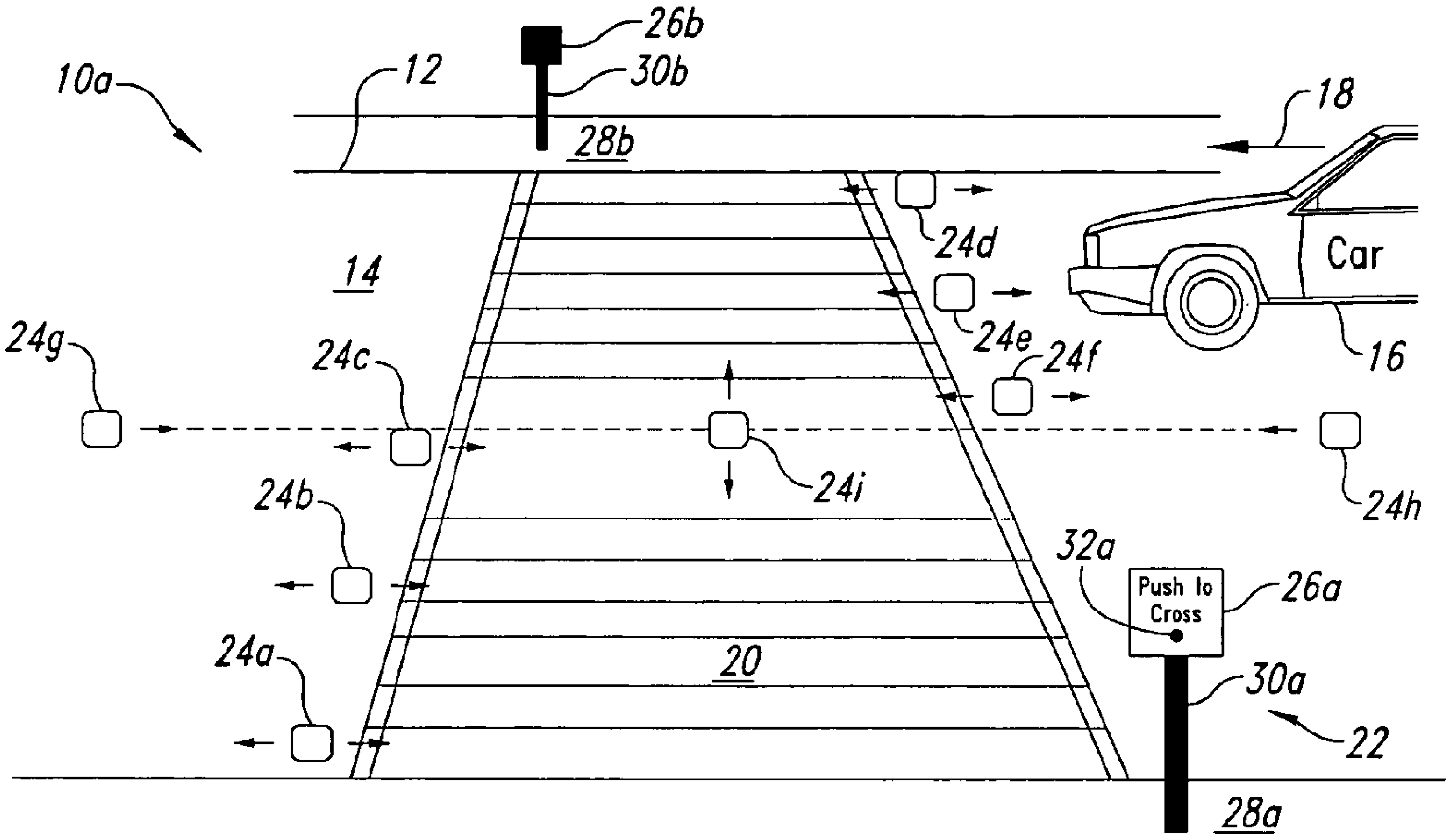

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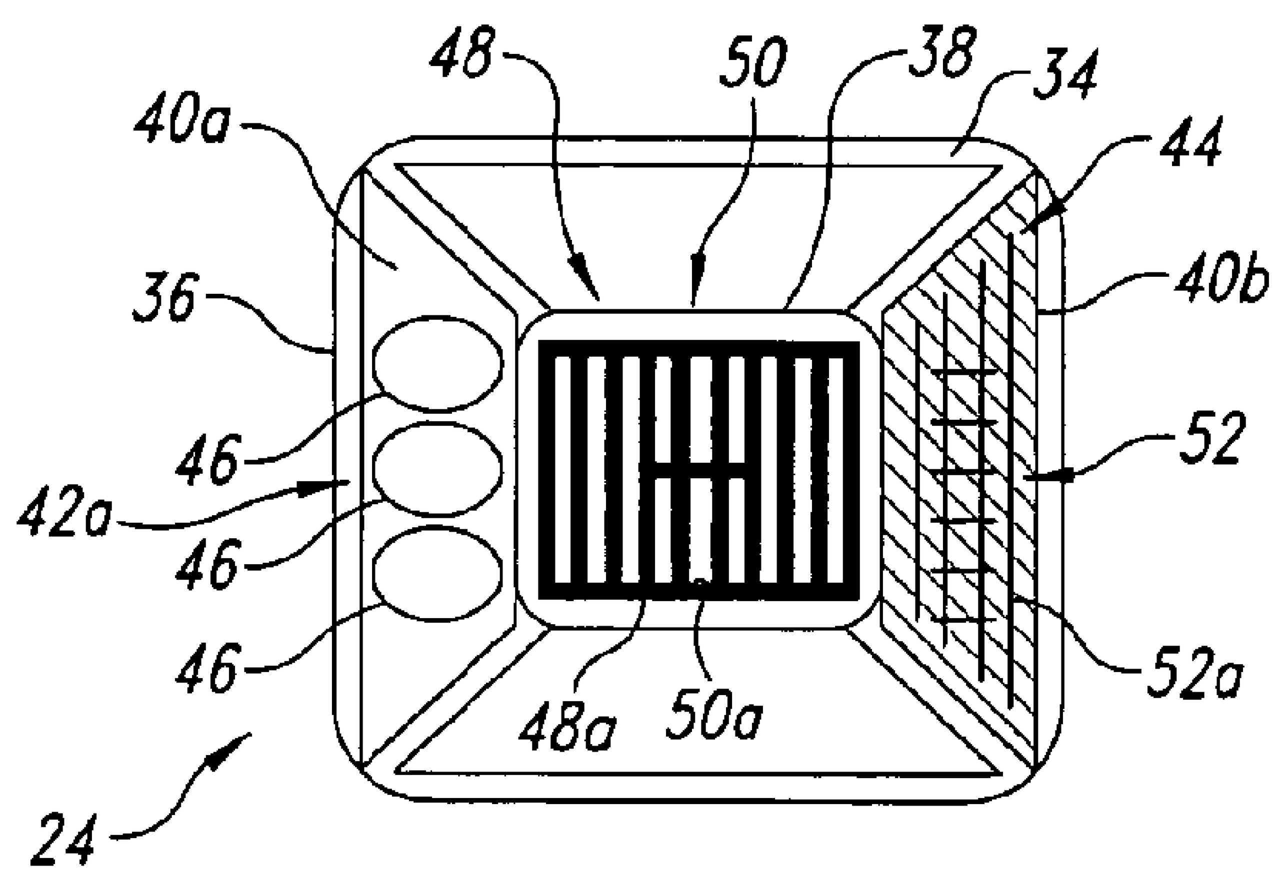

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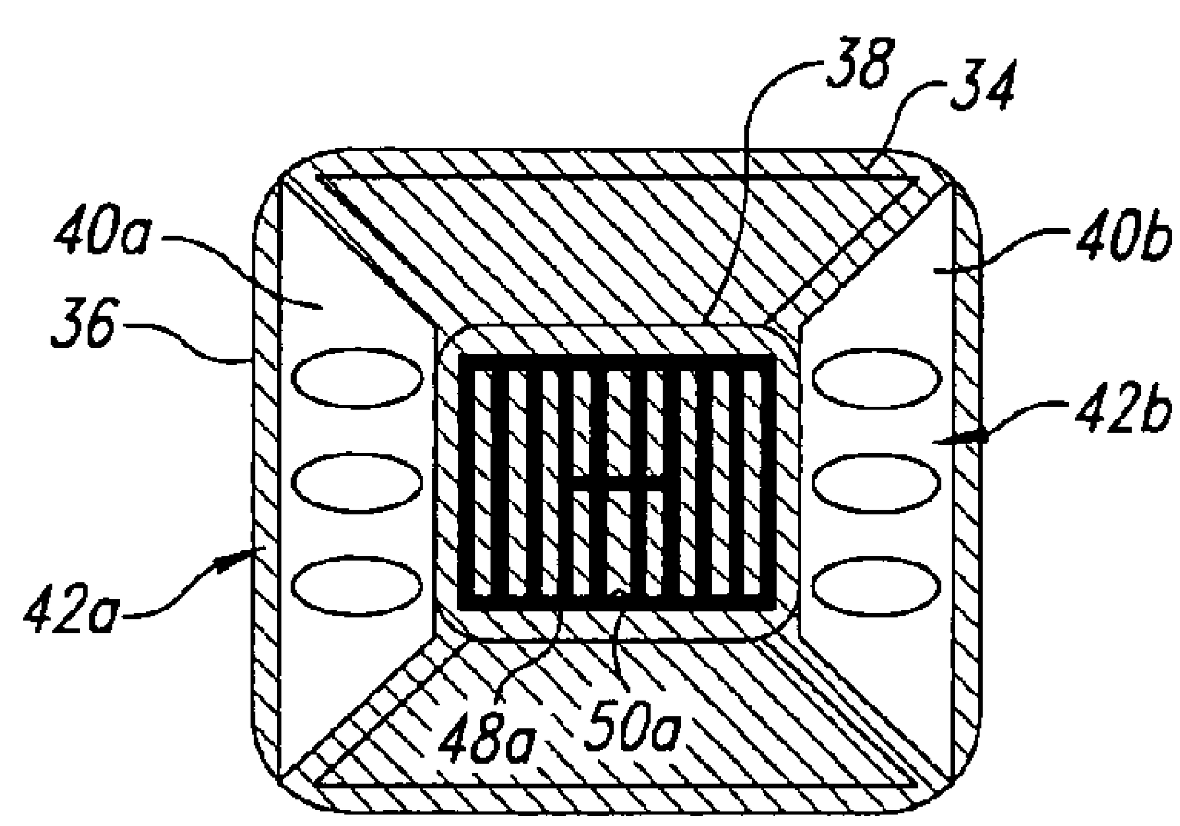

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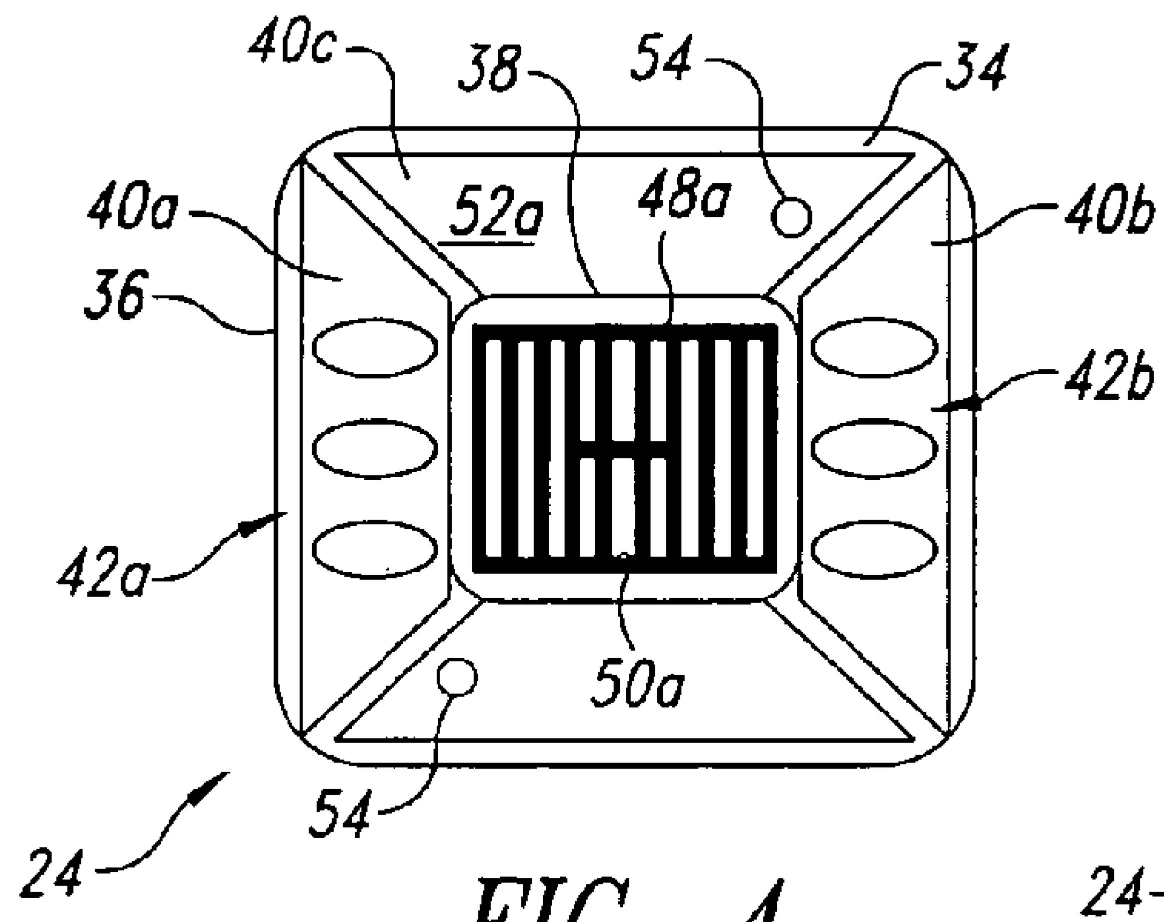

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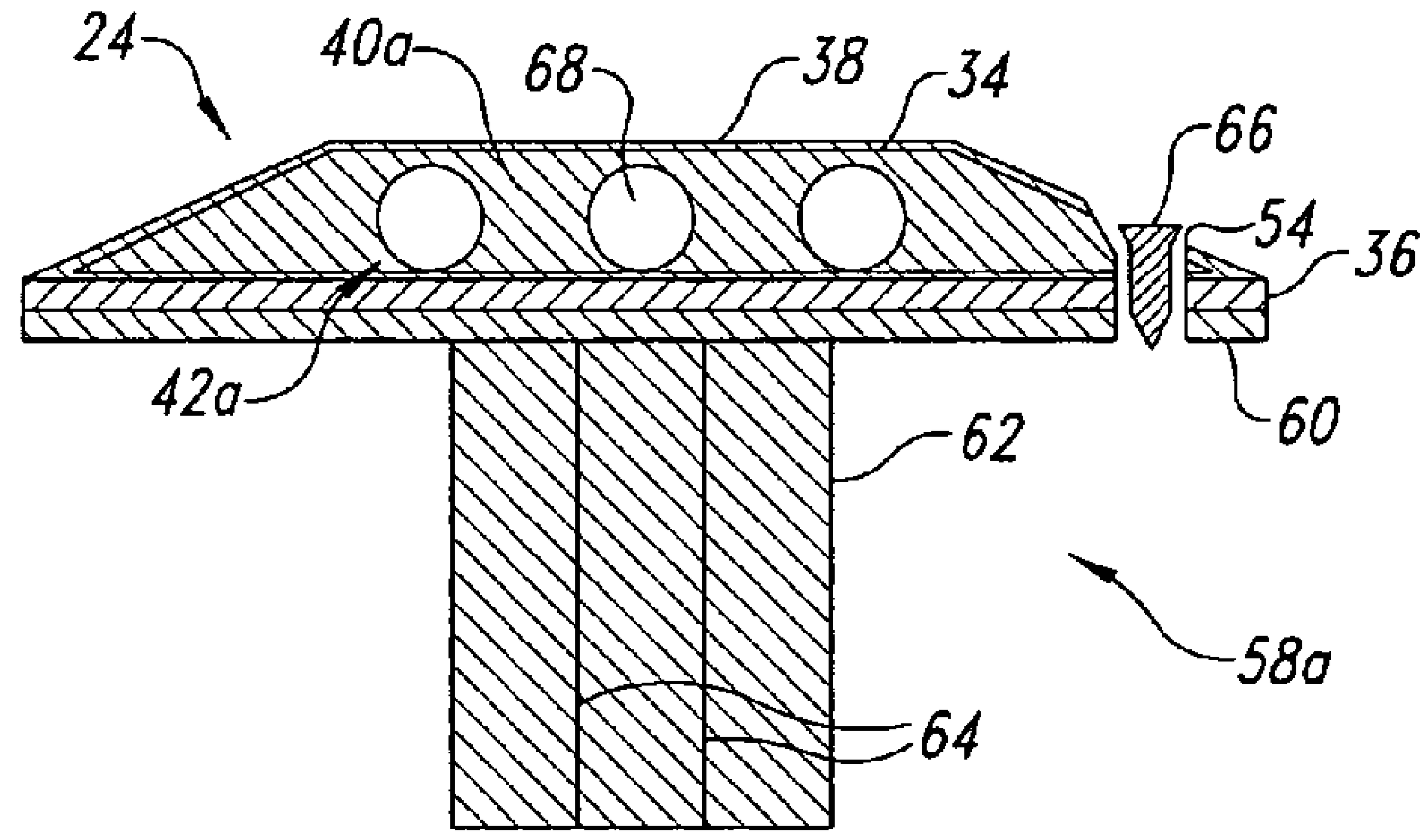

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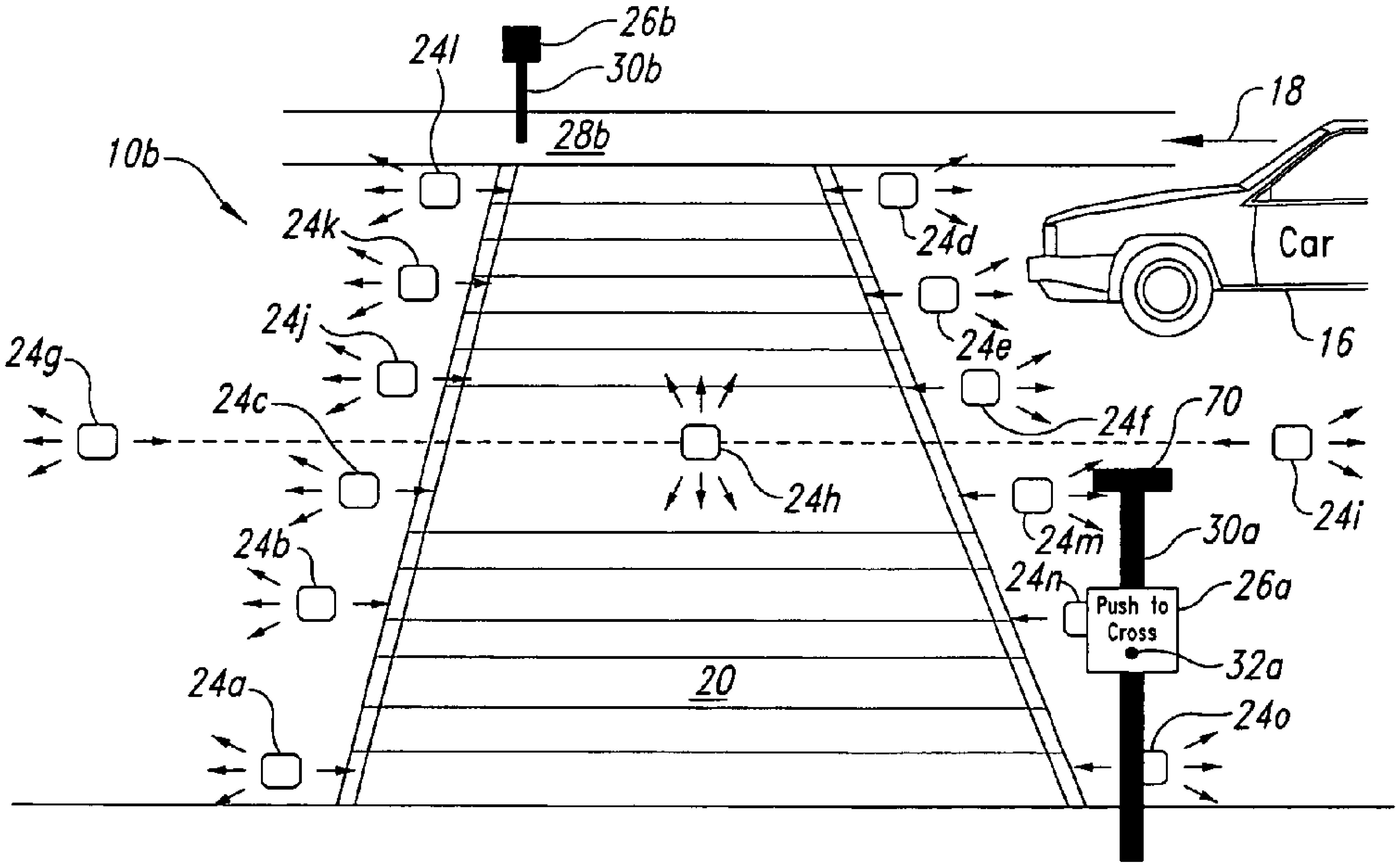

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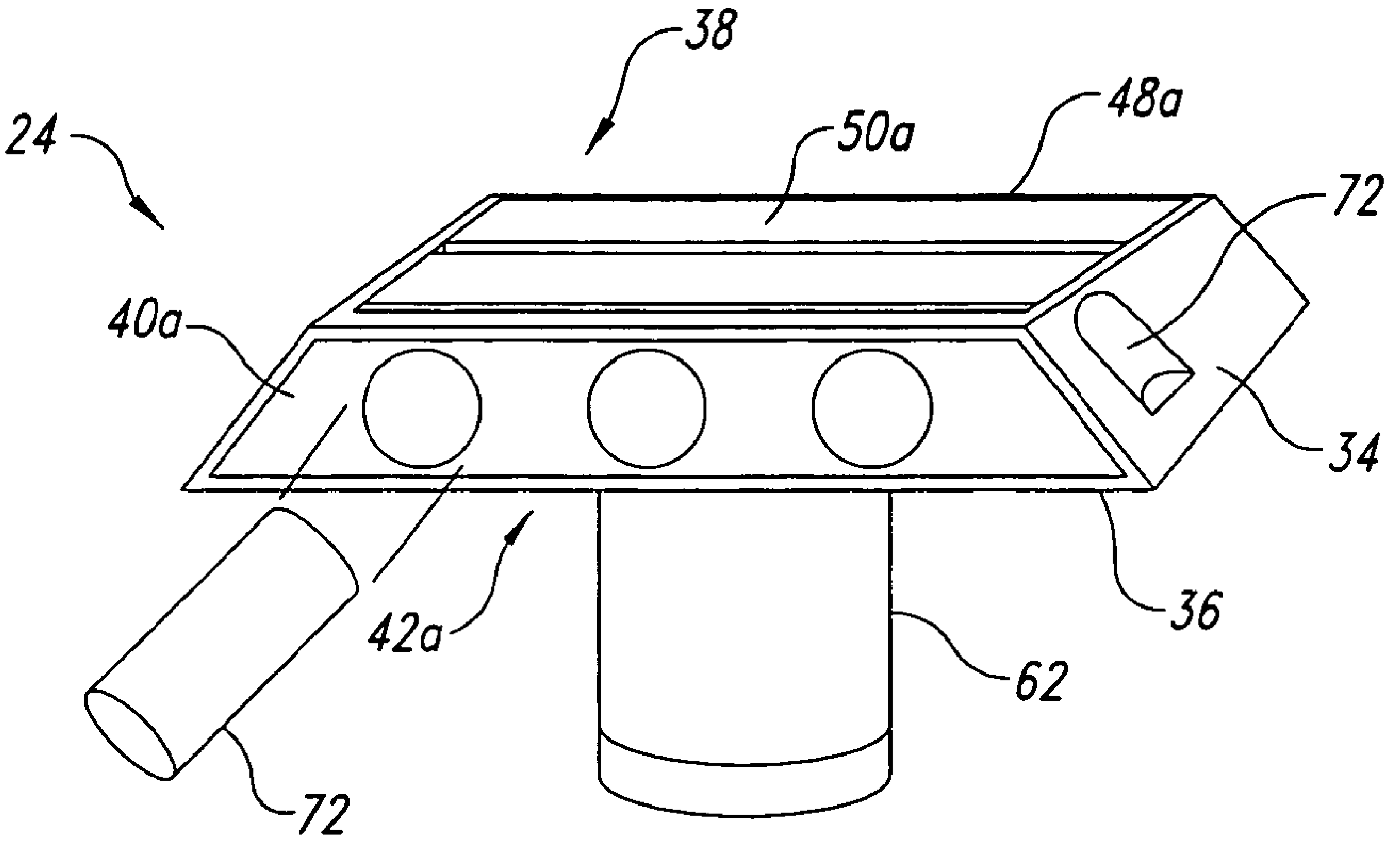
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42a
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72

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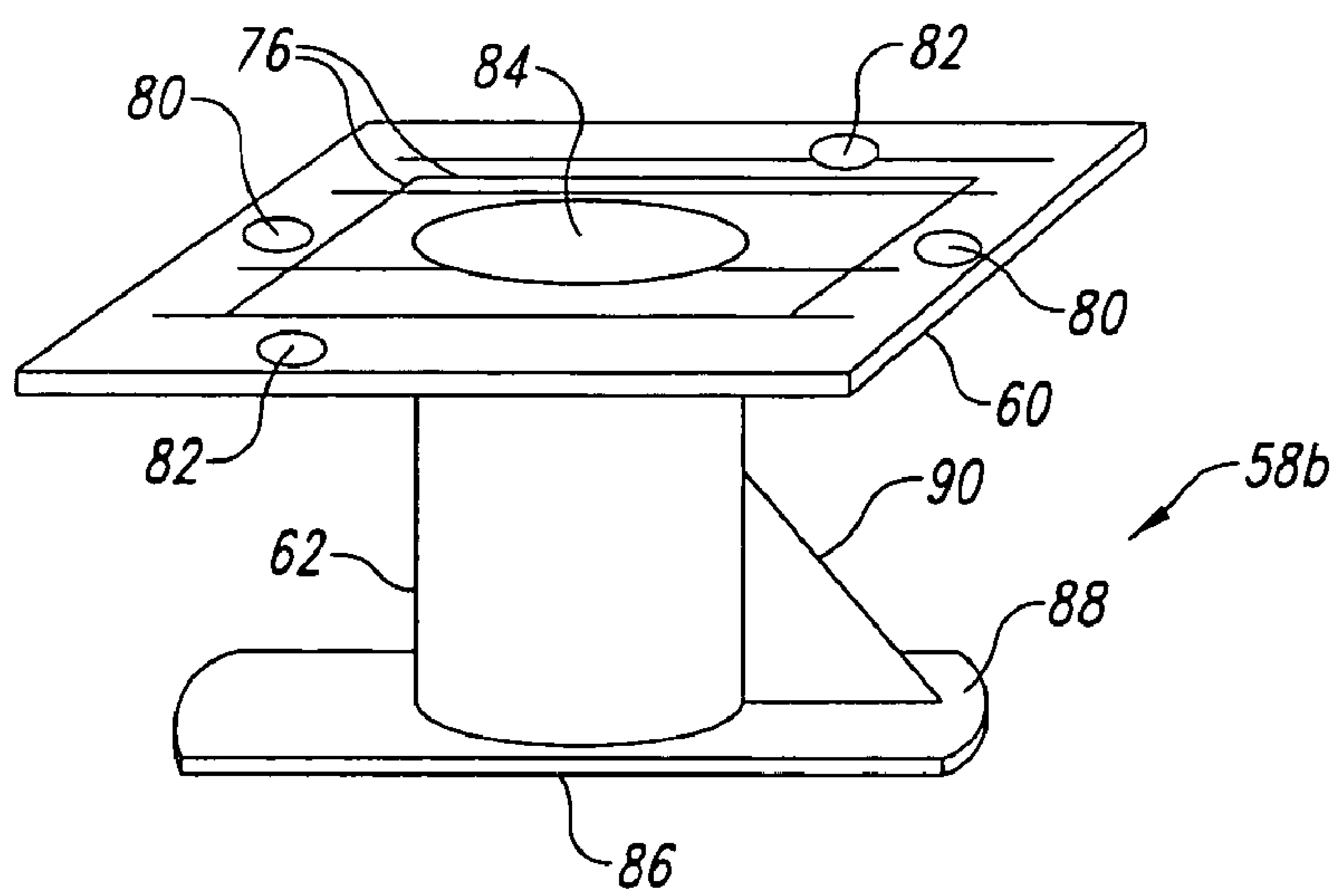
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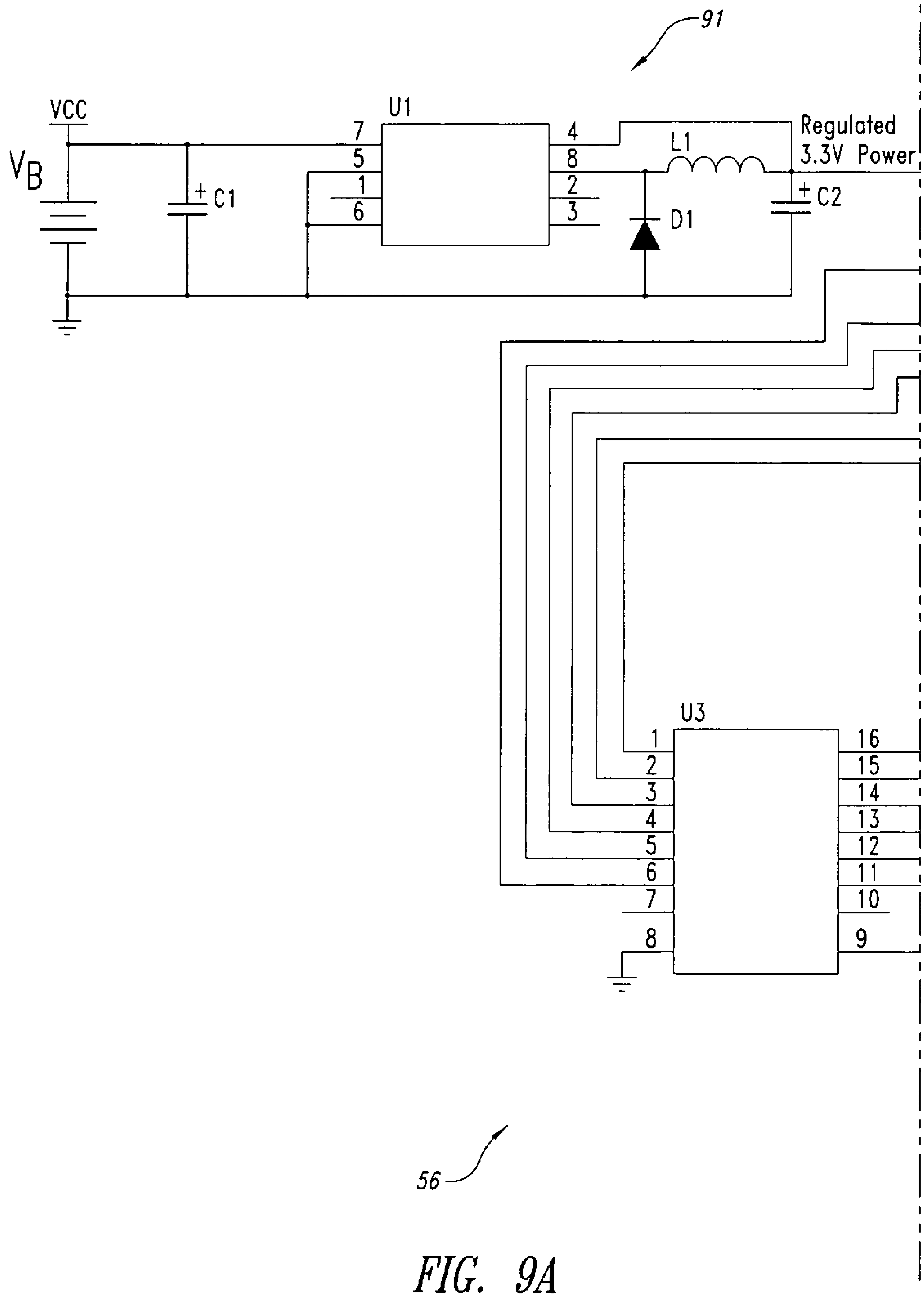
88
86

FIG. 8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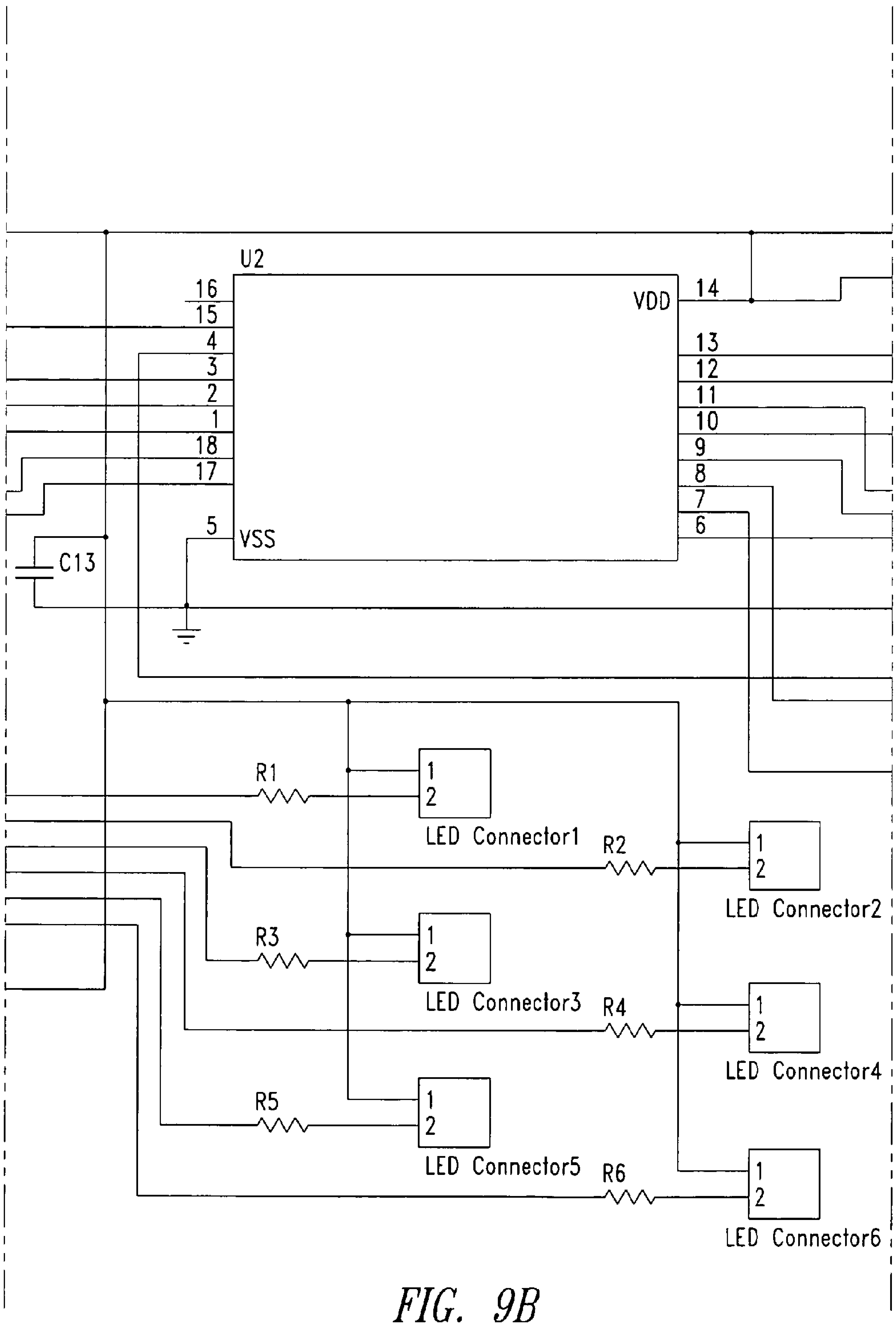
VCC
V_B
C1
U1
7
5
1
6
4
8
2
3
L1
D1
C2
Regulated
3.3V Power
U3
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
56

FIG. 9A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3
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17
5
VSS
VDD
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13
12
11
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9
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6
C13
R1
1
2
LED Connector1
R2
1
2
LED Connector2
R3
1
2
LED Connector3
R4
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LED Connector4
R5
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LED Connector5
R6
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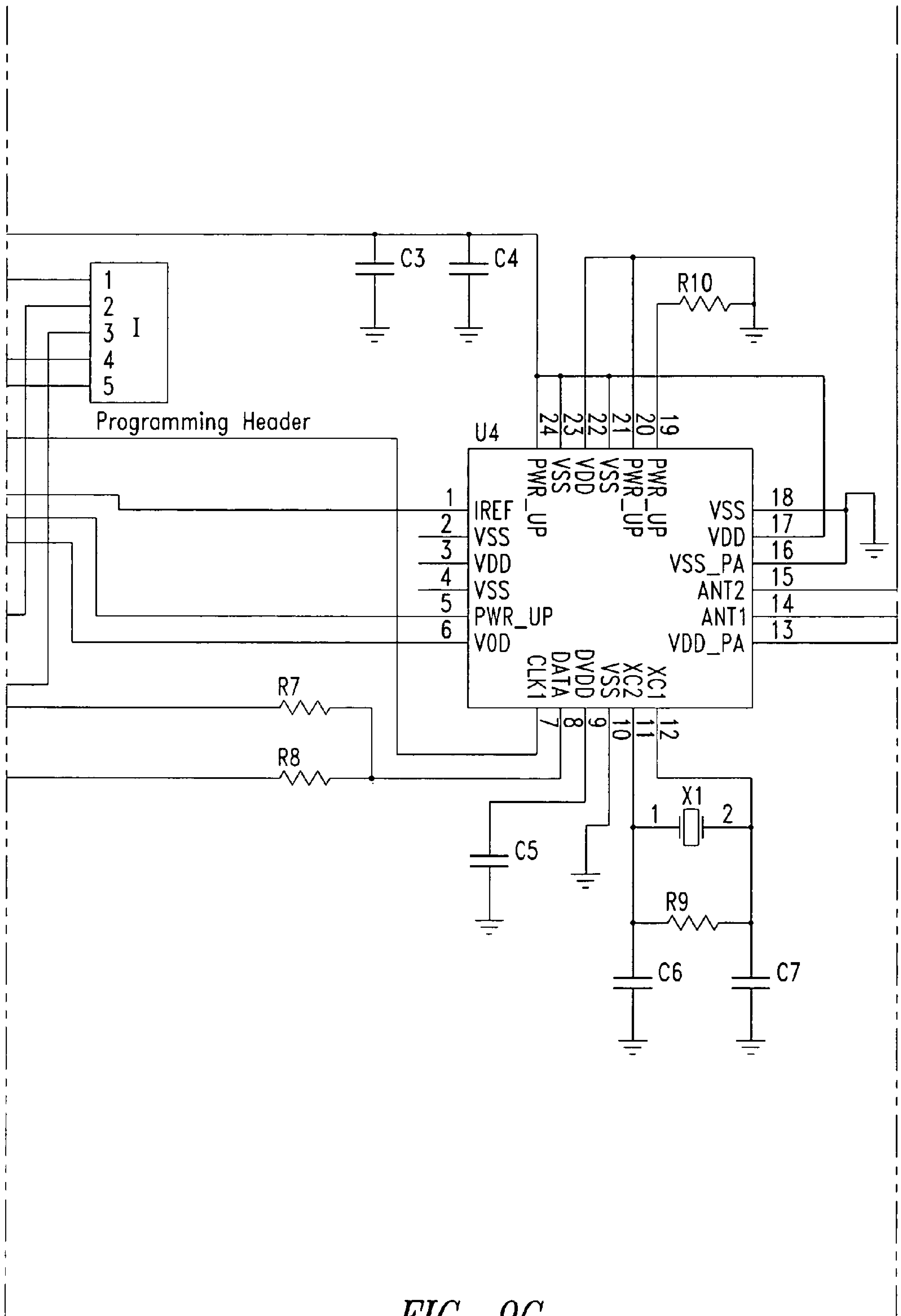
2
LED Connector6

FIG. 9B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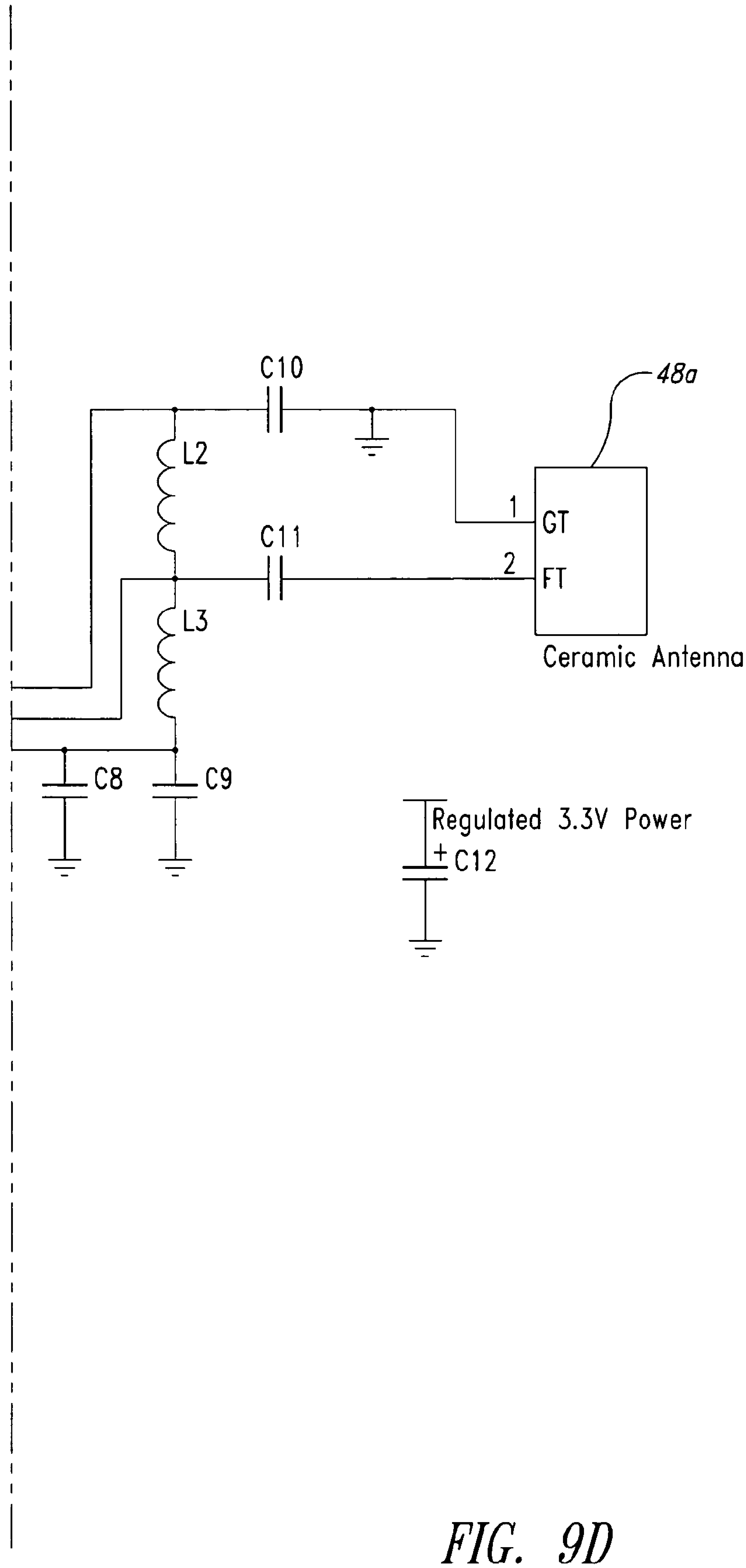
C4
R10
1
2
3
4
5
I
Programming Header
U4
24 23 22 21 20 19
PWR_UP
VSS
VDD
VSS
PWR_UP
PWR_UP
1 IREF
2 VSS
3 VDD
4 VSS
5 PWR_UP
6 VOD
VSS 18
VDD 17
VSS_PA 16
ANT2 15
ANT1 14
VDD_PA 13
CLK1
DATA
DVDD
VSS
XC2
XC1
7 8 9 10 11 12
R7
R8
X1
1
2
C5
R9
C6
C7

FIG. 9C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L2
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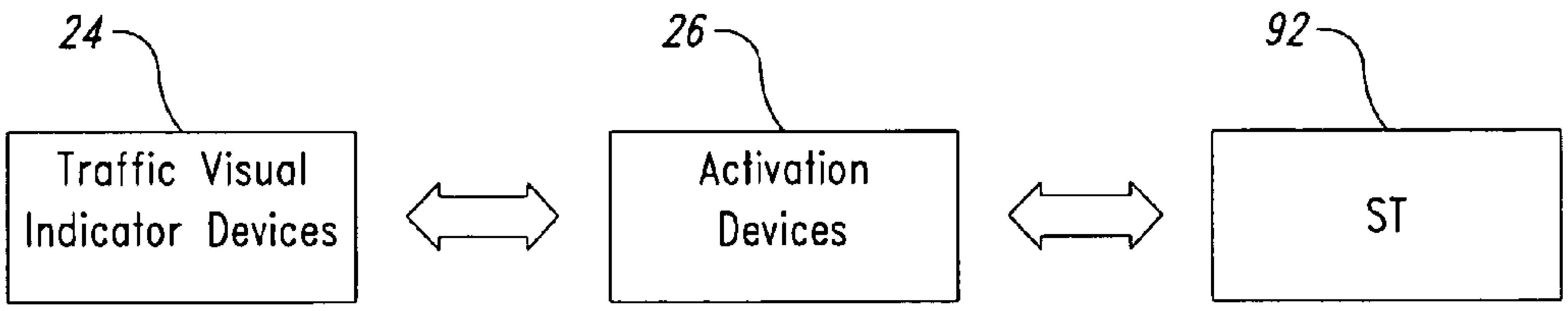
GT
C11
2
FT
L3
Ceramic Antenna
C8
C9
Regulated 3.3V Power
+
C12

FIG. 9D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Traffic Visual Indicator Devices
Activation Devices
ST

FIG. 10

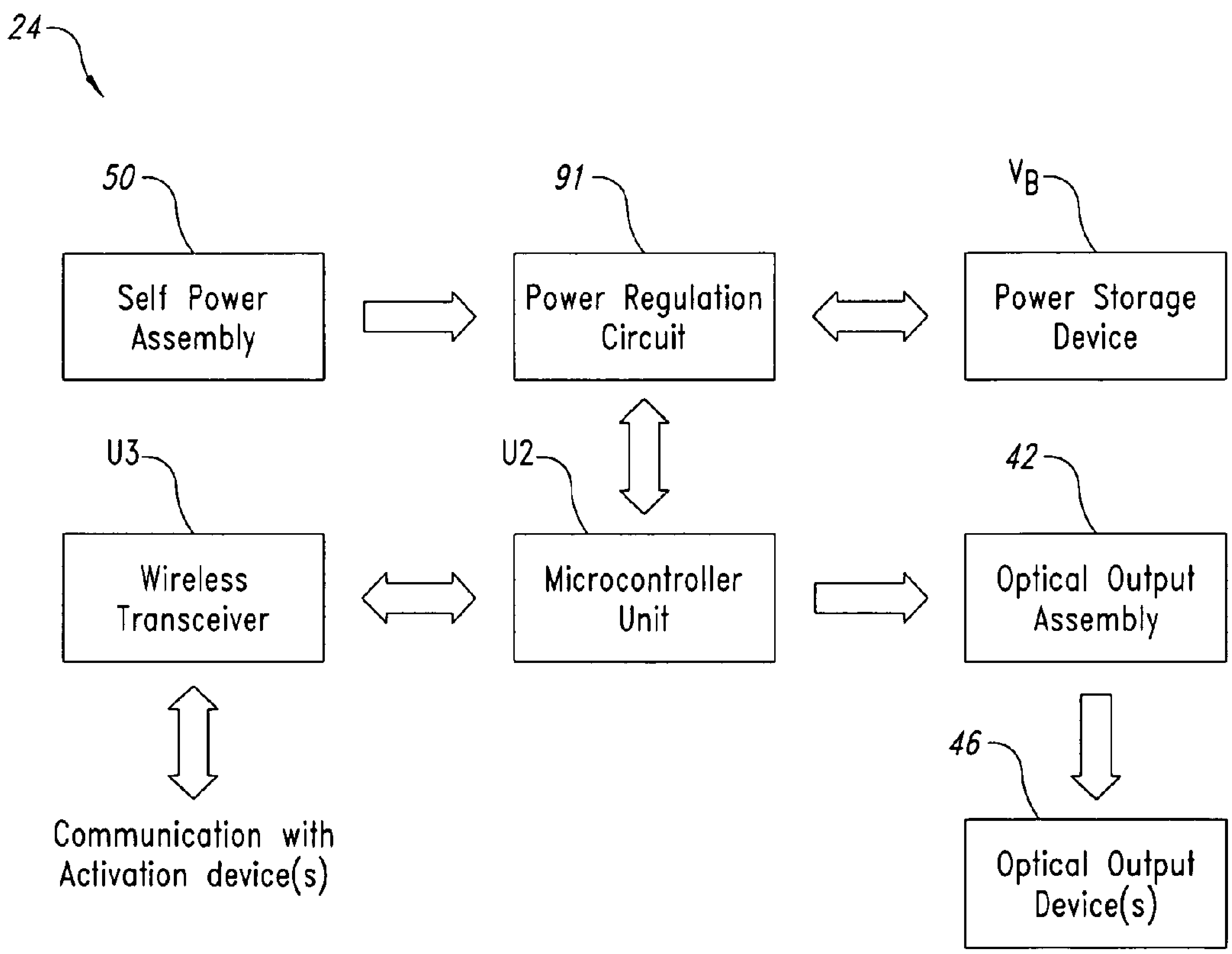
24
50
91
V_B
Self Power Assembly
Power Regulation Circuit
Power Storage Device
U3
U2
42
Wireless Transceiver
Microcontroller Unit
Optical Output Assembly
46
Communication with Activation device(s)
Optical Output Device(s)

FIG. 11

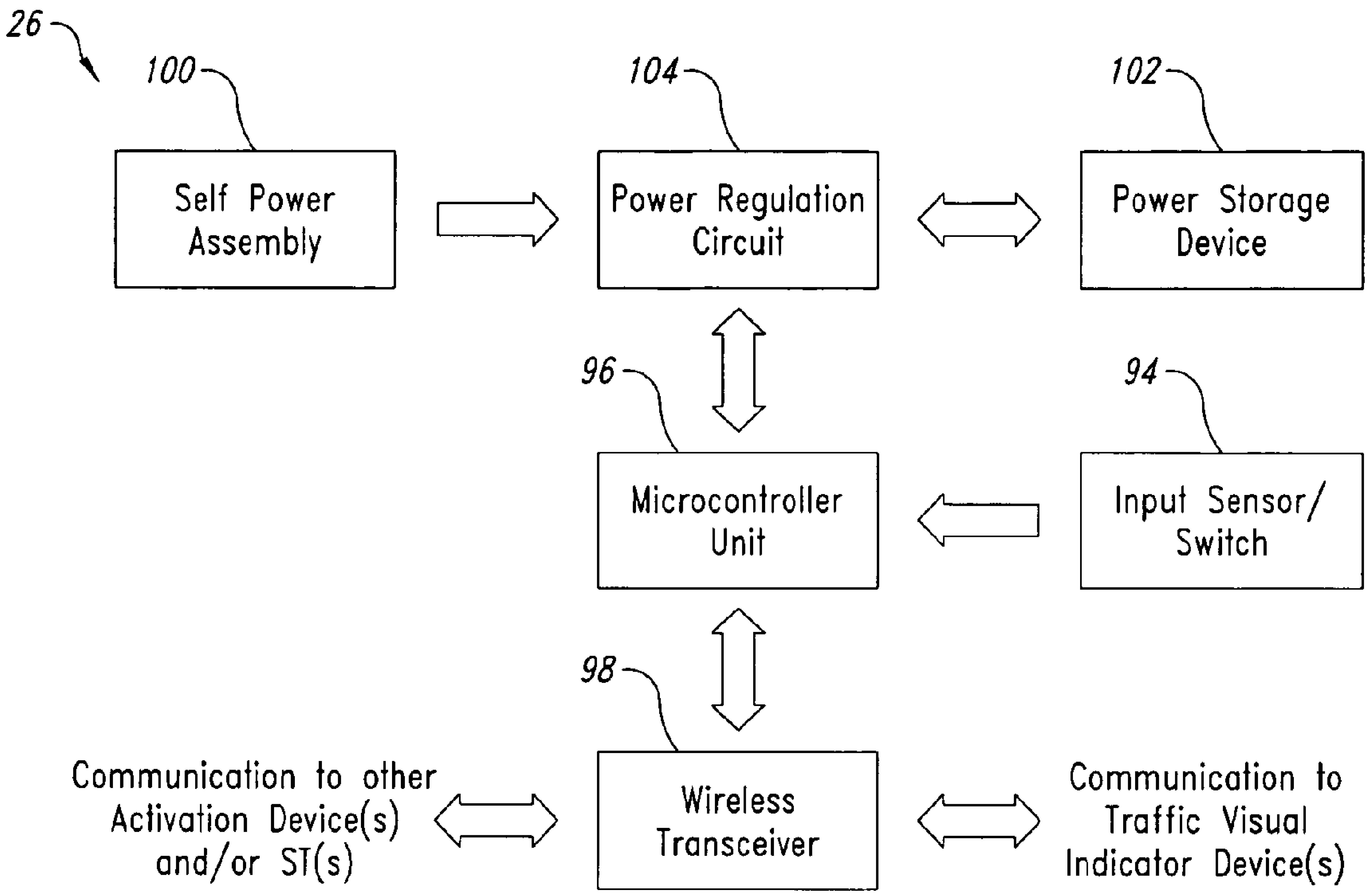
26
100
104
102
Self Power Assembly
Power Regulation Circuit
Power Storage Device
96
94
Microcontroller Unit
Input Sensor/ Switch
98
Communication to other Activation Device(s) and/or ST(s)
Wireless Transceiver
Communication to Traffic Visual Indicator Device(s)

FIG. 12

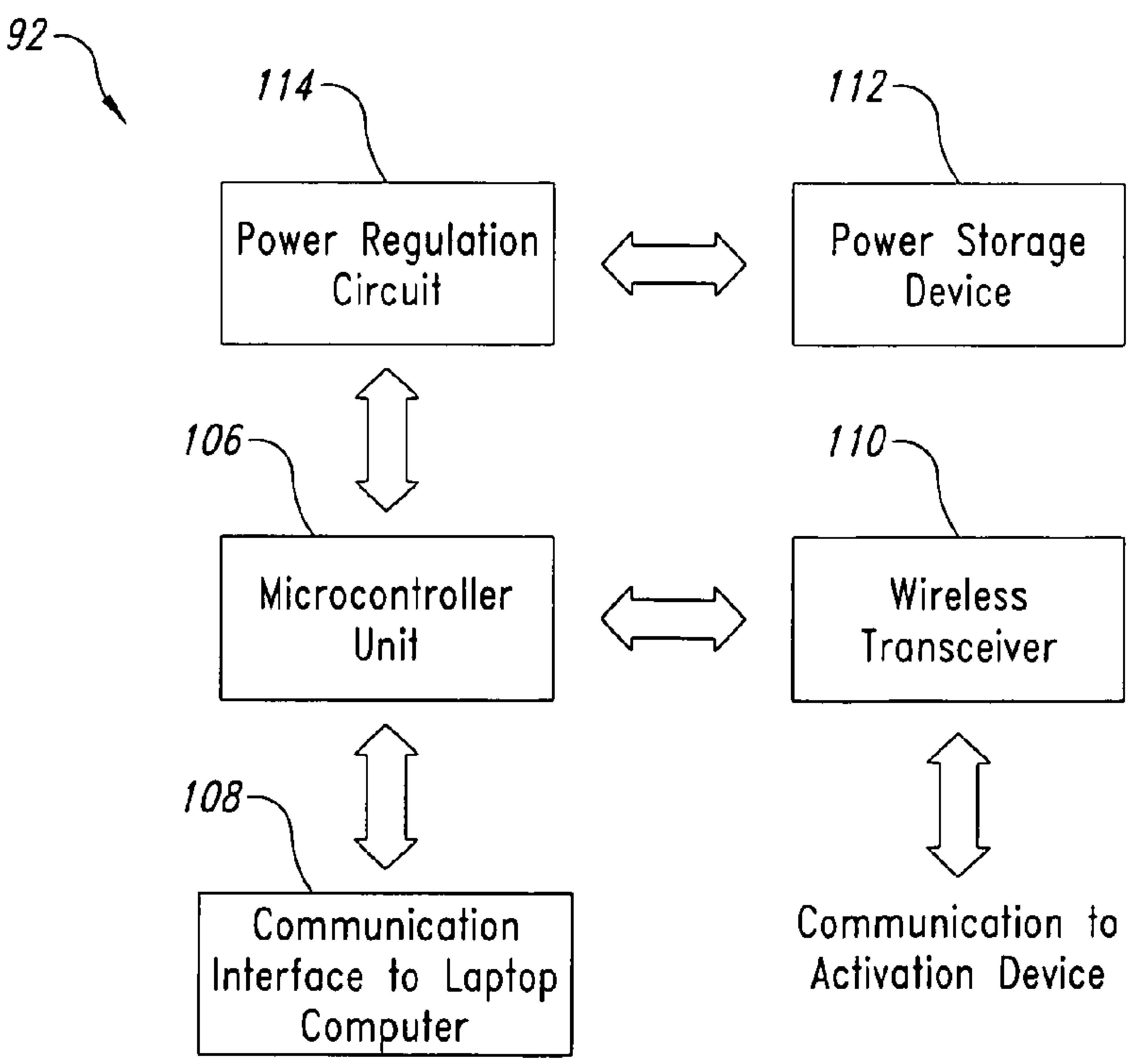
92
114
112
Power Regulation Circuit
Power Storage Device
106
110
Microcontroller Unit
Wireless Transceiver
108
Communication Interface to Laptop Computer
Communication to Activation Device

FIG. 13

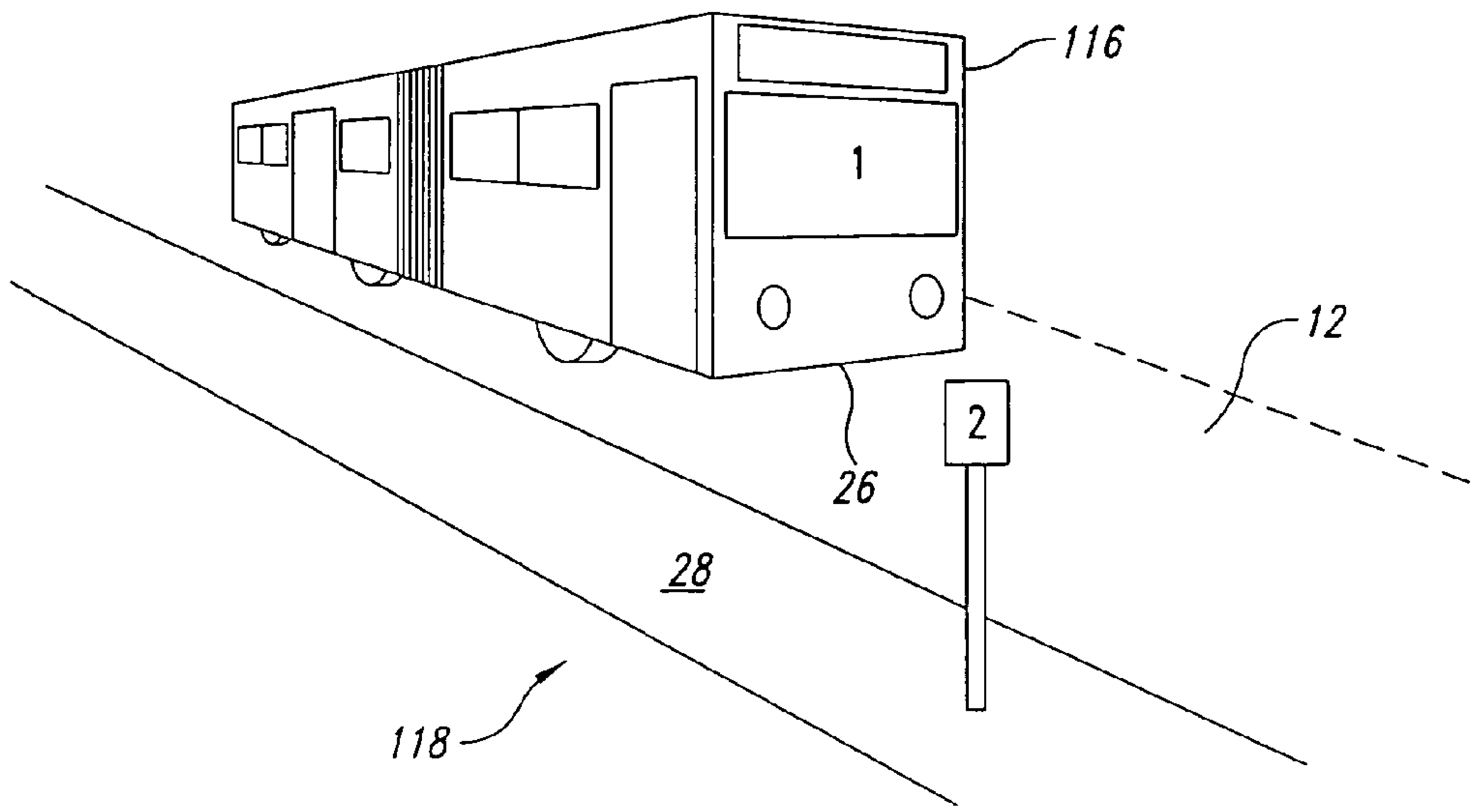

FIG. 14

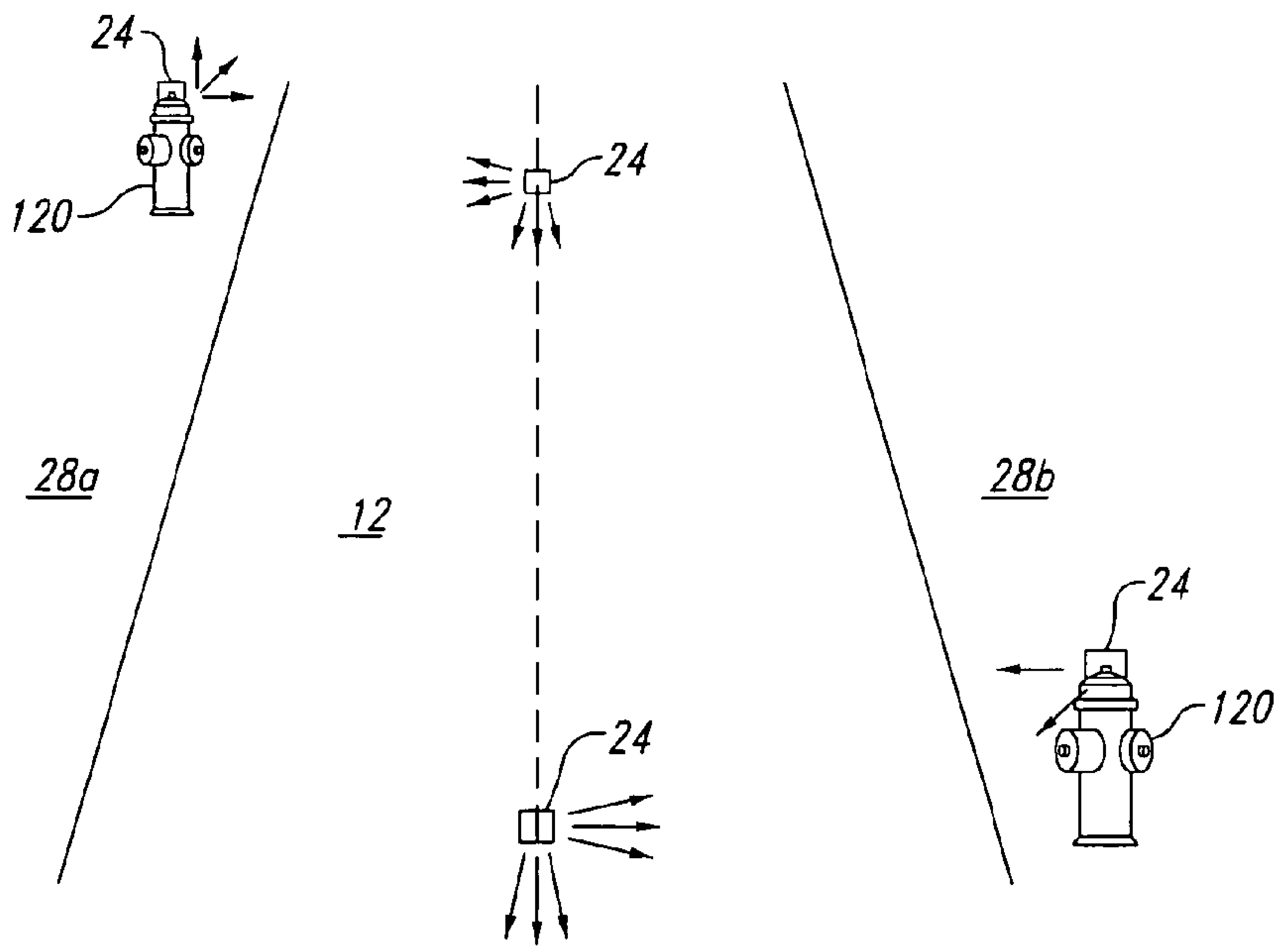

FIG. 15

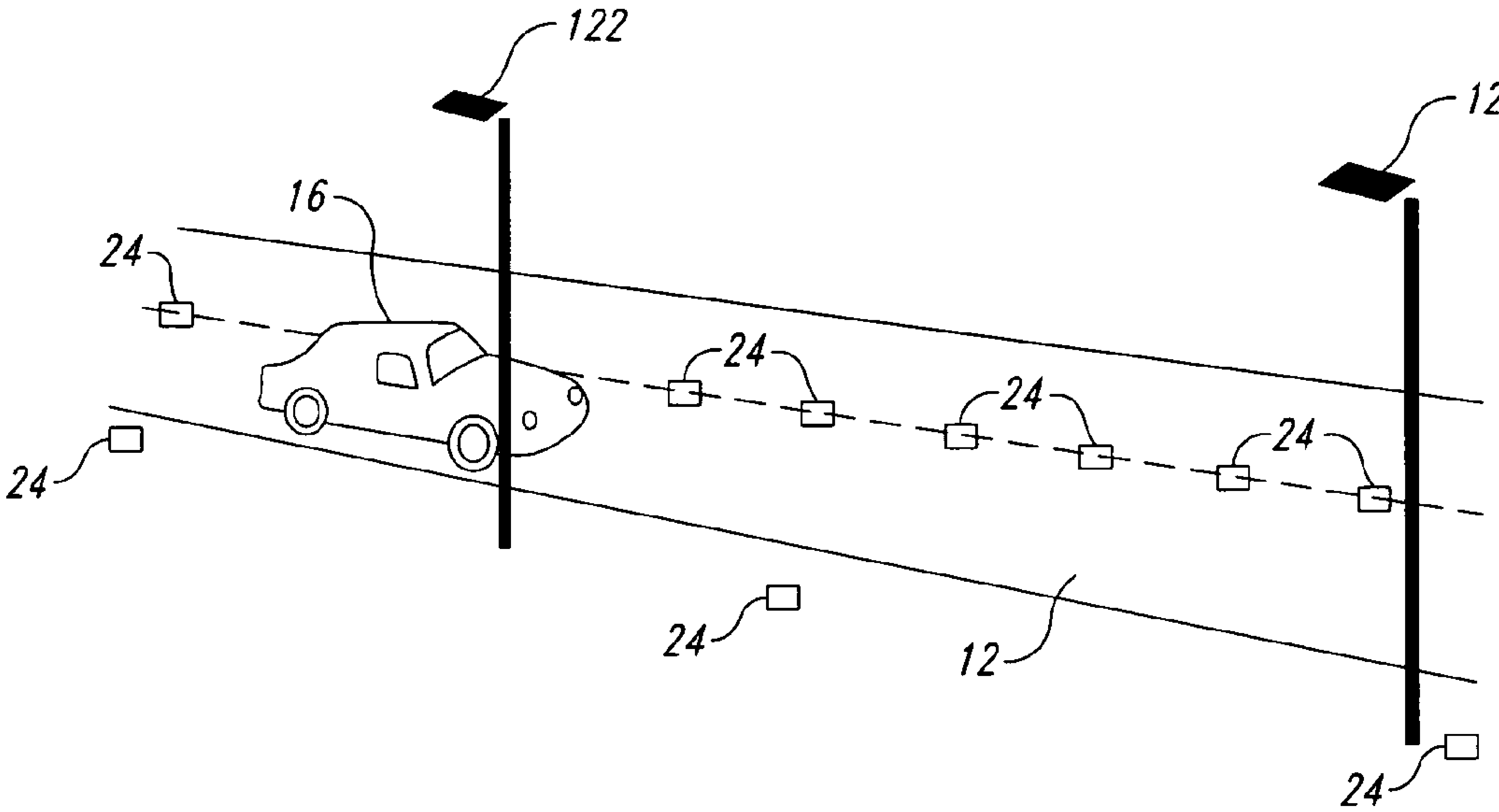
122
122
16
24
24
24
24
24
24
24
12
24

FIG. 16

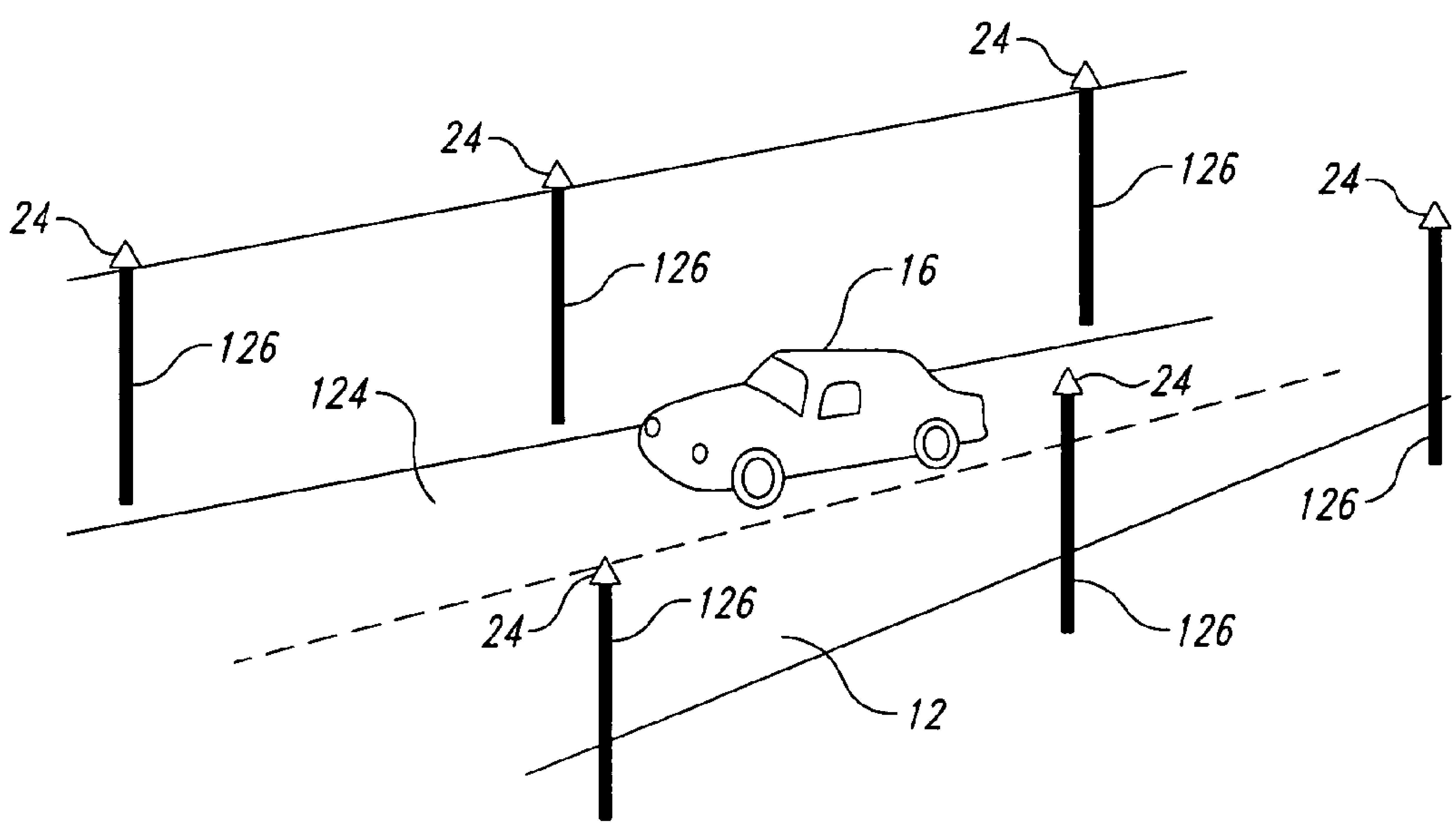
24
24
24
24
126
126
126
16
124
24
126
24
126
126
12

FIG. 17

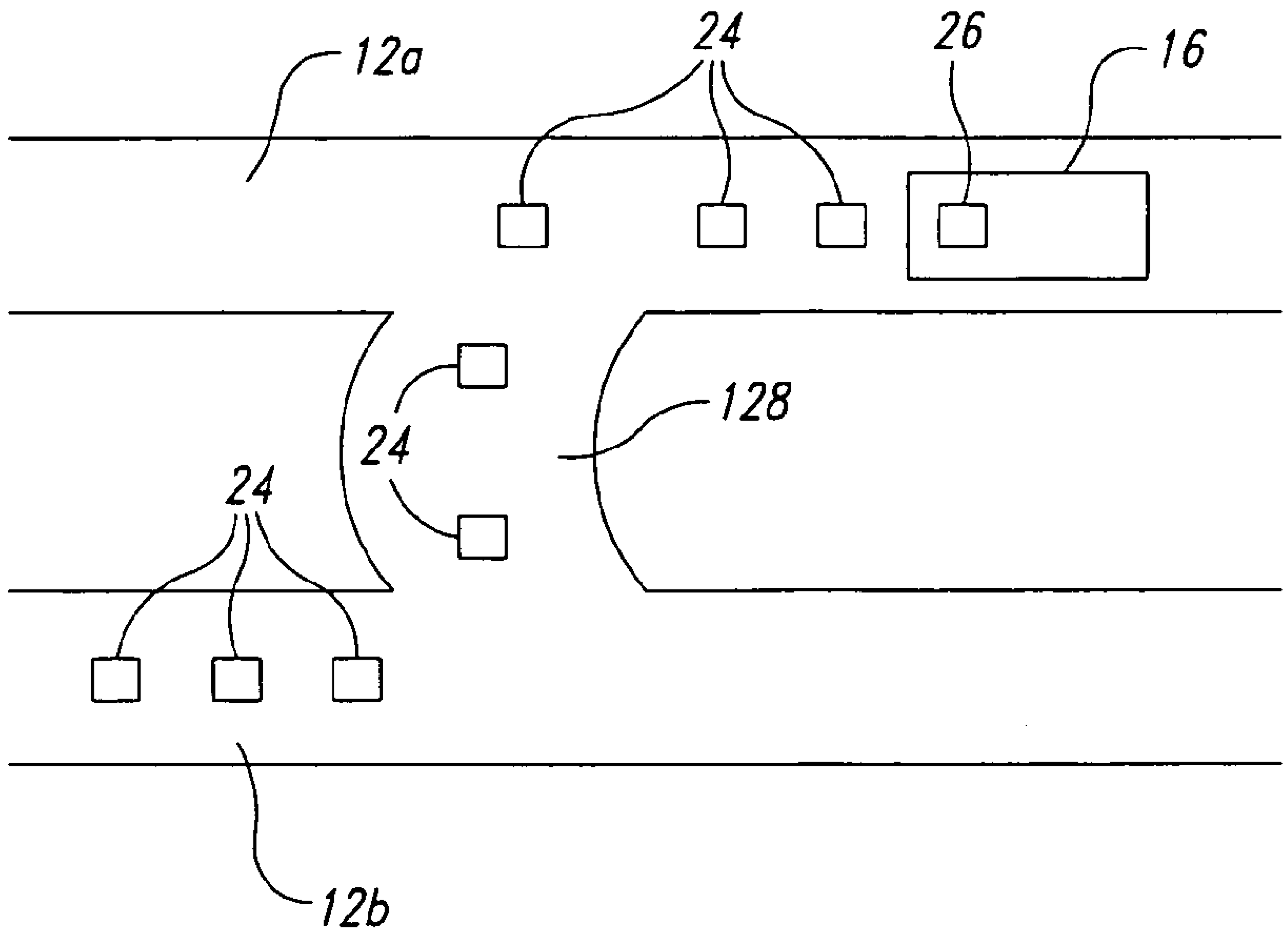
12a
24
26
16
24
128
24
12b

FIG. 18

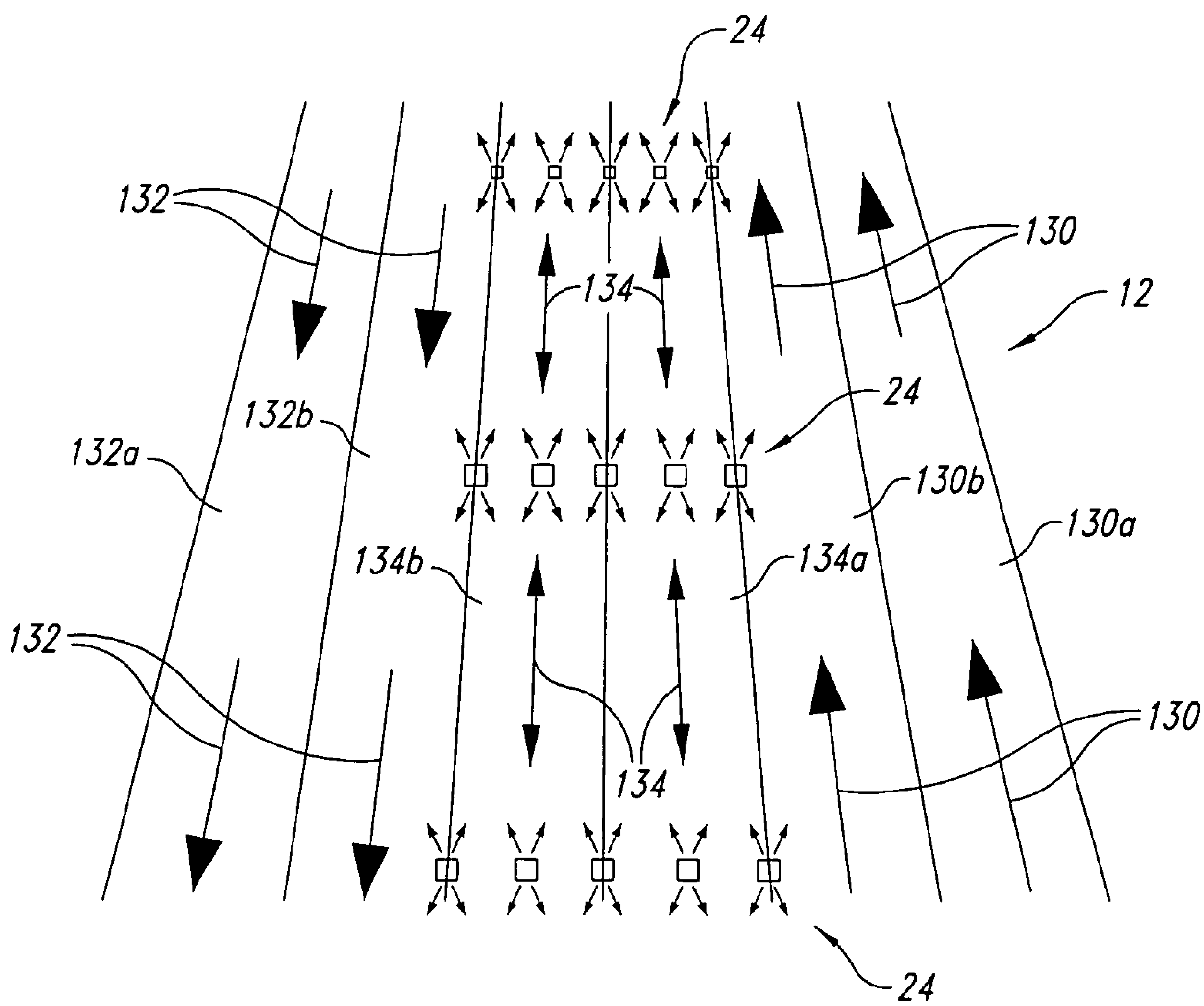
24
132
130
134
12
132b
24
132a
130b
130a
134b
134a
132
130
134
24

FIG. 19

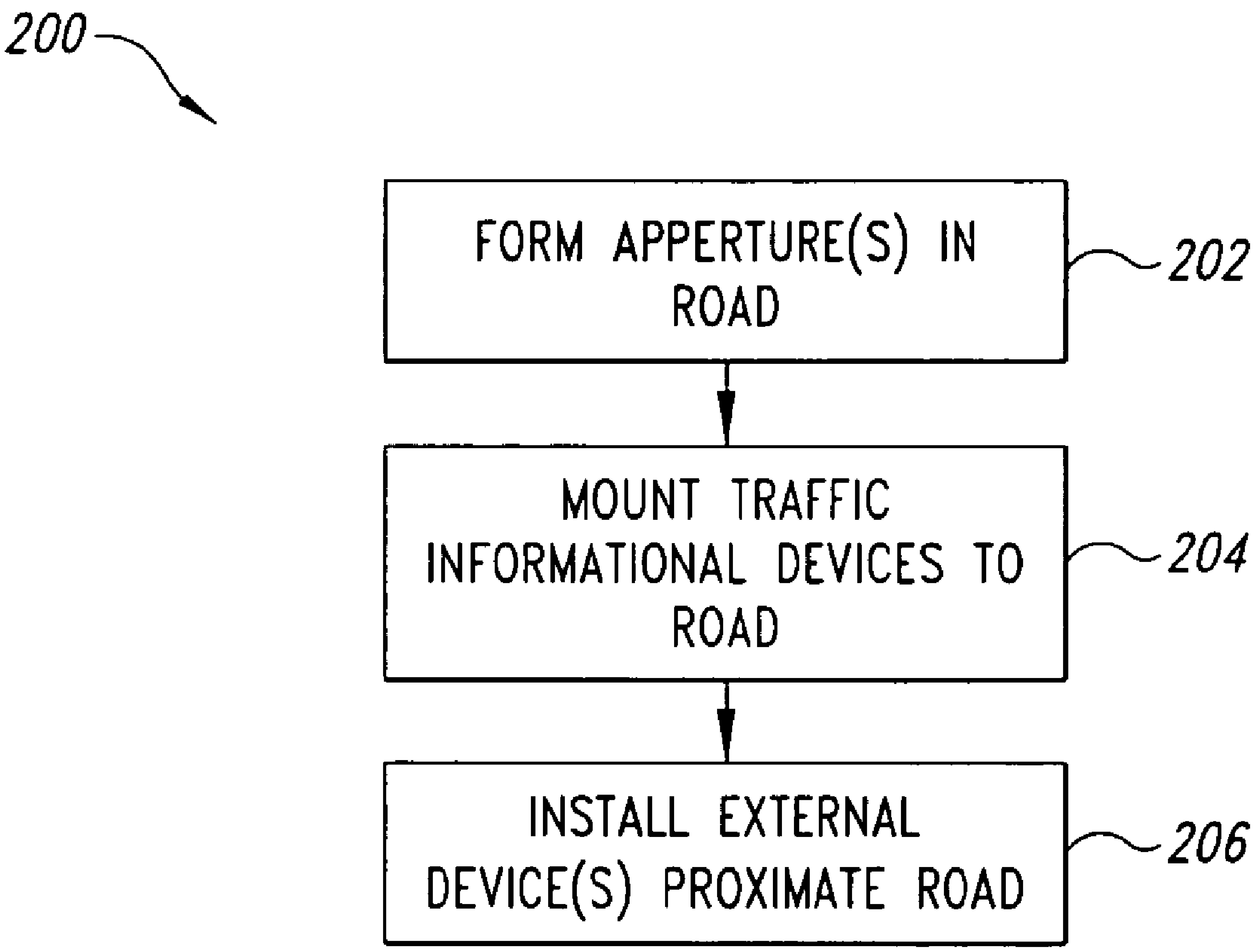
200
FORM APPERTURE(S) IN ROAD
202
MOUNT TRAFFIC INFORMATIONAL DEVICES TO ROAD
204
INSTALL EXTERNAL DEVICE(S) PROXIMATE ROAD
206

FIG. 20

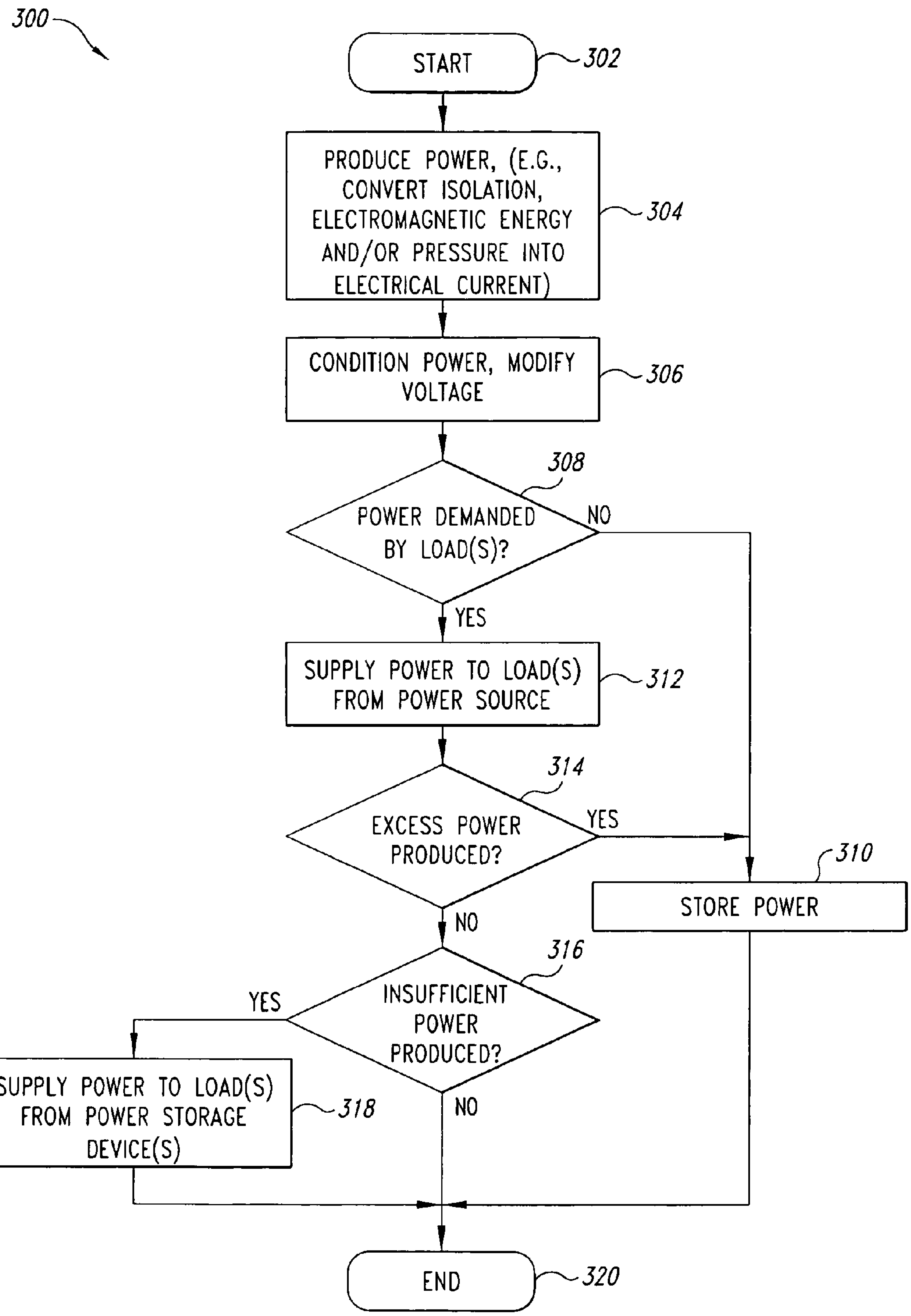
300
START
302
PRODUCE POWER, (E.G., CONVERT ISOLATION, ELECTROMAGNETIC ENERGY AND/OR PRESSURE INTO ELECTRICAL CURRENT)
304
CONDITION POWER, MODIFY VOLTAGE
306
308
POWER DEMANDED BY LOAD(S)?
NO
YES
SUPPLY POWER TO LOAD(S) FROM POWER SOURCE
312
314
EXCESS POWER PRODUCED?
YES
310
STORE POWER
NO
316
INSUFFICIENT POWER PRODUCED?
YES
SUPPLY POWER TO LOAD(S) FROM POWER STORAGE DEVICE(S)
318
NO
END
320

FIG. 21

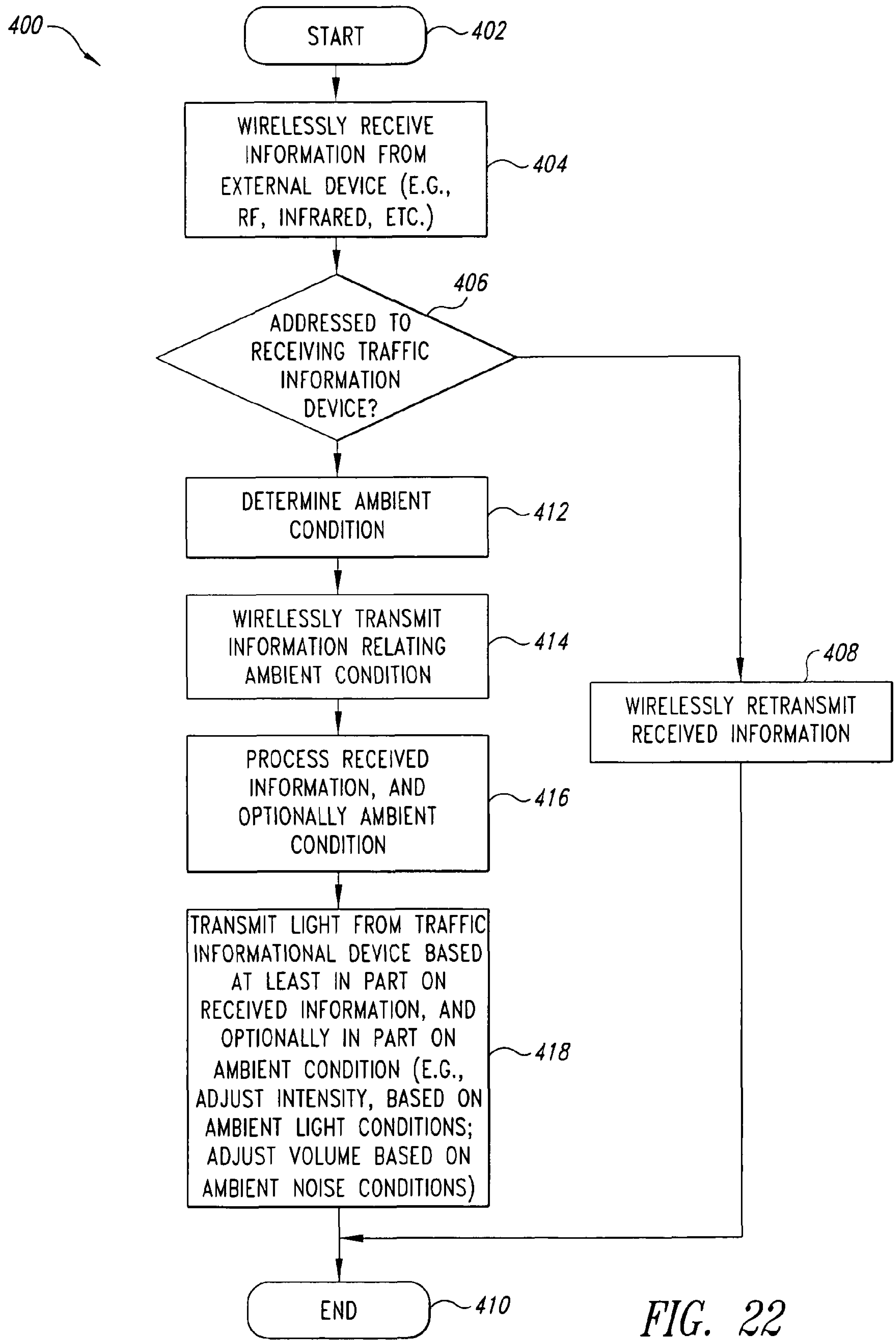
400
START
402
WIRELESSLY RECEIVE INFORMATION FROM EXTERNAL DEVICE (E.G., RF, INFRARED, ETC.)
404
ADDRESSED TO RECEIVING TRAFFIC INFORMATION DEVICE?
406
DETERMINE AMBIENT CONDITION
412
WIRELESSLY TRANSMIT INFORMATION RELATING AMBIENT CONDITION
414
PROCESS RECEIVED INFORMATION, AND OPTIONALLY AMBIENT CONDITION
416
TRANSMIT LIGHT FROM TRAFFIC INFORMATIONAL DEVICE BASED AT LEAST IN PART ON RECEIVED INFORMATION, AND OPTIONALLY IN PART ON AMBIENT CONDITION (E.G., ADJUST INTENSITY, BASED ON AMBIENT LIGHT CONDITIONS; ADJUST VOLUME BASED ON AMBIENT NOISE CONDITIONS)
418
WIRELESSLY RETRANSMIT RECEIVED INFORMATION
408
END
410

FIG. 22

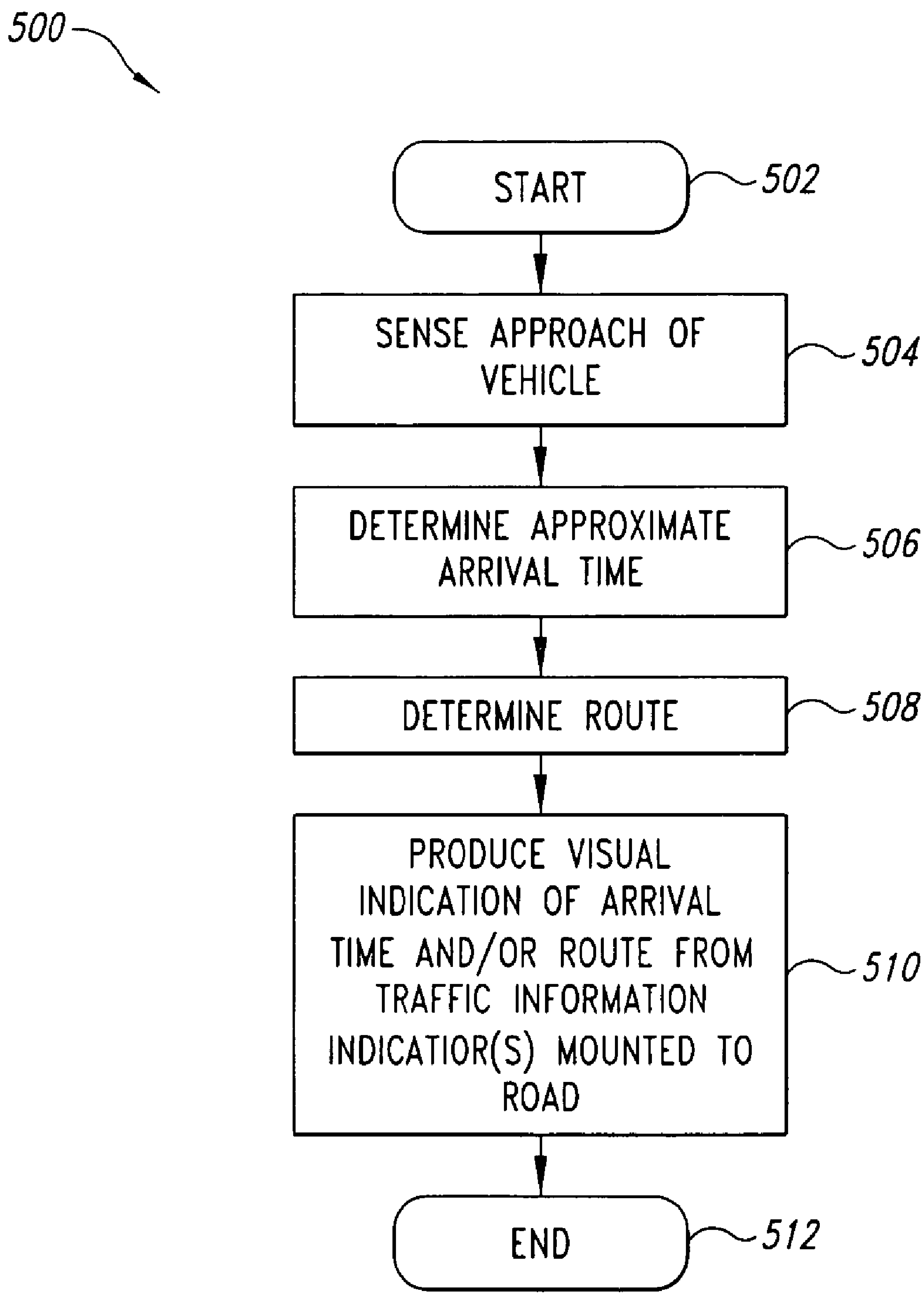
500
START
502
SENSE APPROACH OF VEHICLE
504
DETERMINE APPROXIMATE ARRIVAL TIME
506
DETERMINE ROUTE
508
PRODUCE VISUAL INDICATION OF ARRIVAL TIME AND/OR ROUTE FROM TRAFFIC INFORMATION INDICATIOR(S) MOUNTED TO ROAD
510
END
512

FIG. 23

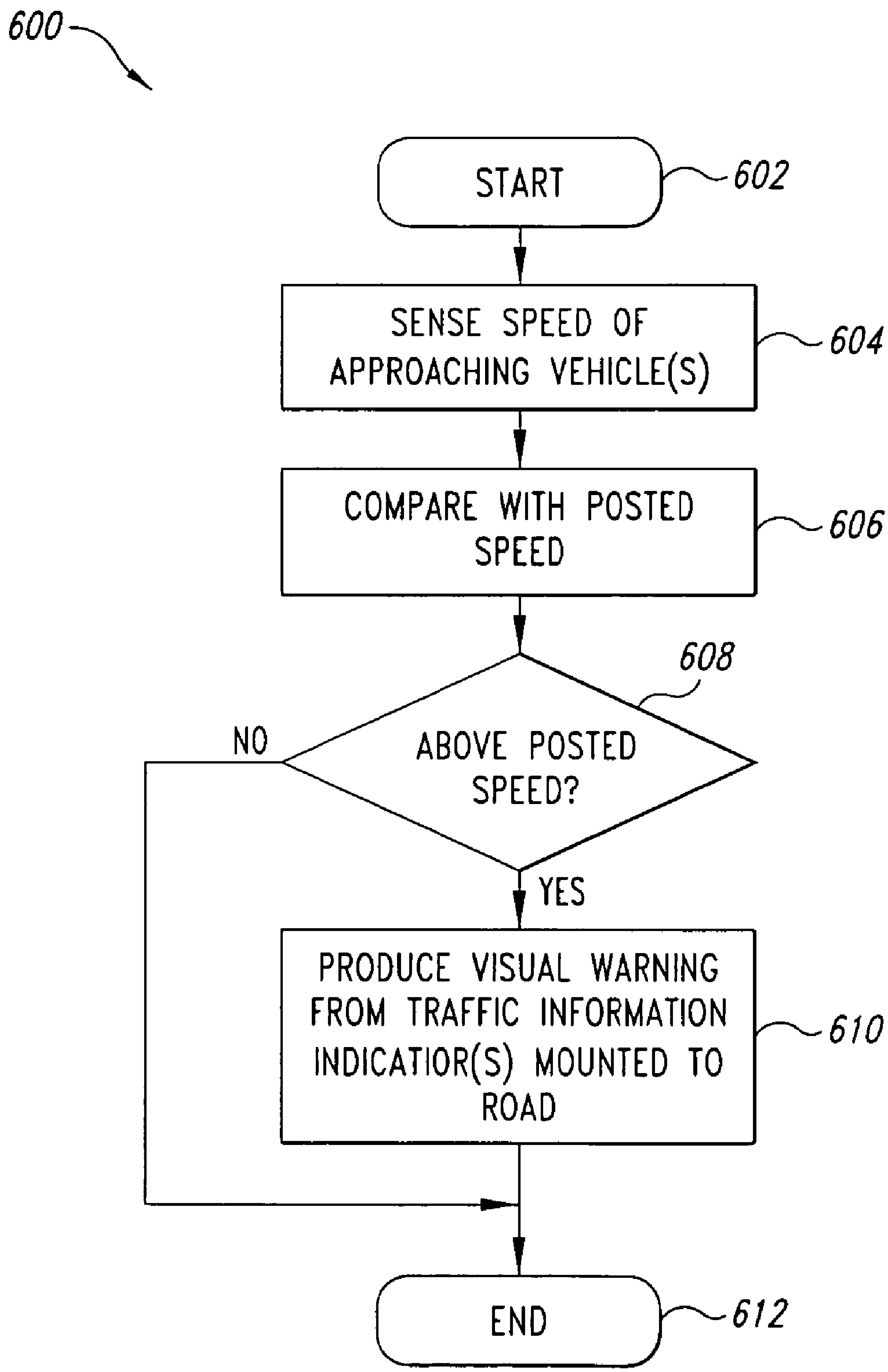
600
START
602
SENSE SPEED OF APPROACHING VEHICLE(S)
604
COMPARE WITH POSTED SPEED
606
608
ABOVE POSTED SPEED?
NO
YES
PRODUCE VISUAL WARNING FROM TRAFFIC INFORMATION INDICATIOR(S) MOUNTED TO ROAD
610
END
612

FIG. 24

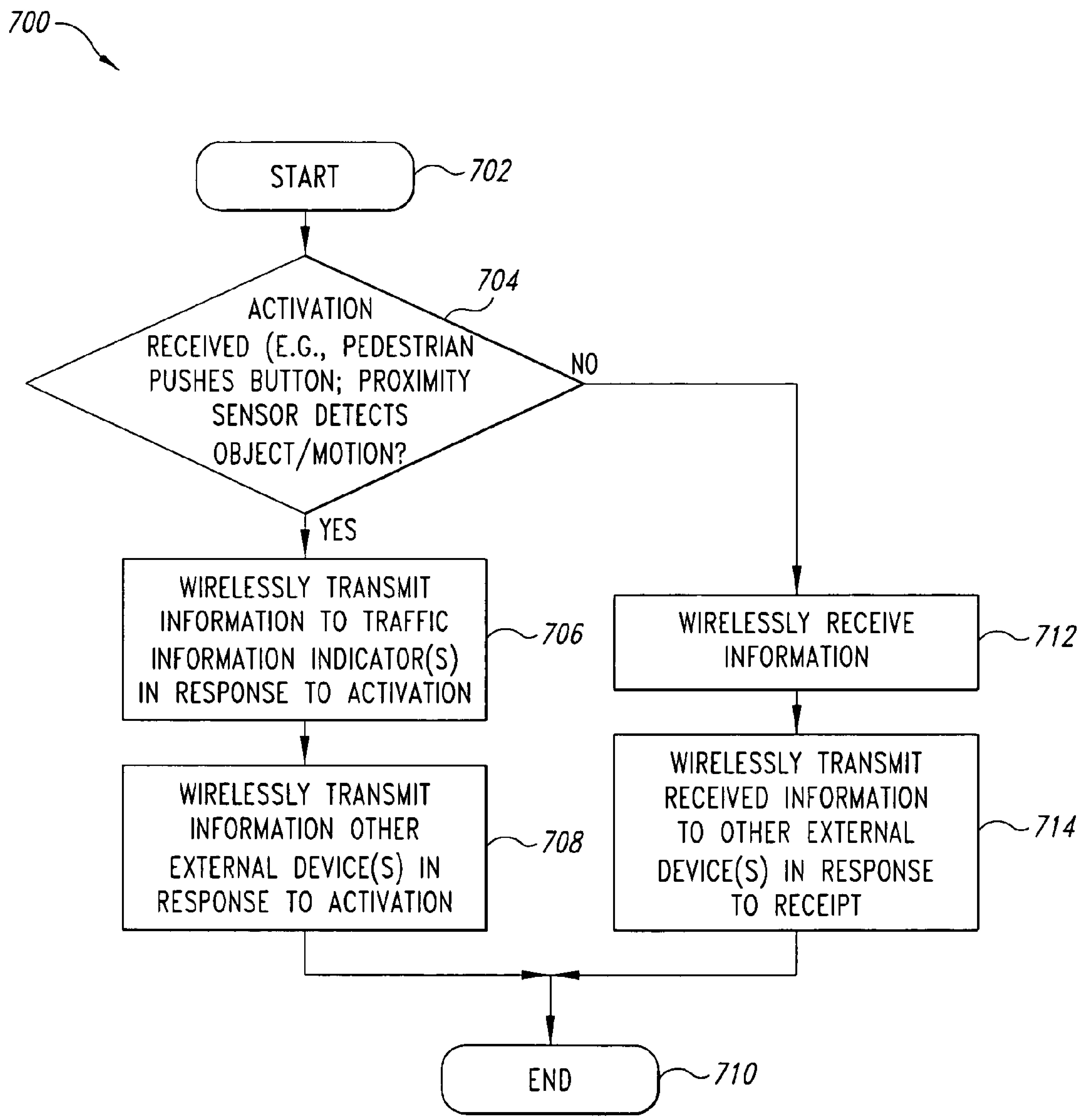
700
START
702
ACTIVATION RECEIVED (E.G., PEDESTRIAN PUSHES BUTTON; PROXIMITY SENSOR DETECTS OBJECT/MOTION?
704
NO
YES
WIRELESSLY TRANSMIT INFORMATION TO TRAFFIC INFORMATION INDICATOR(S) IN RESPONSE TO ACTIVATION
706
WIRELESSLY TRANSMIT INFORMATION OTHER EXTERNAL DEVICE(S) IN RESPONSE TO ACTIVATION
708
WIRELESSLY RECEIVE INFORMATION
712
WIRELESSLY TRANSMIT RECEIVED INFORMATION TO OTHER EXTERNAL DEVICE(S) IN RESPONSE TO RECEIPT
714
END
710

FIG. 25

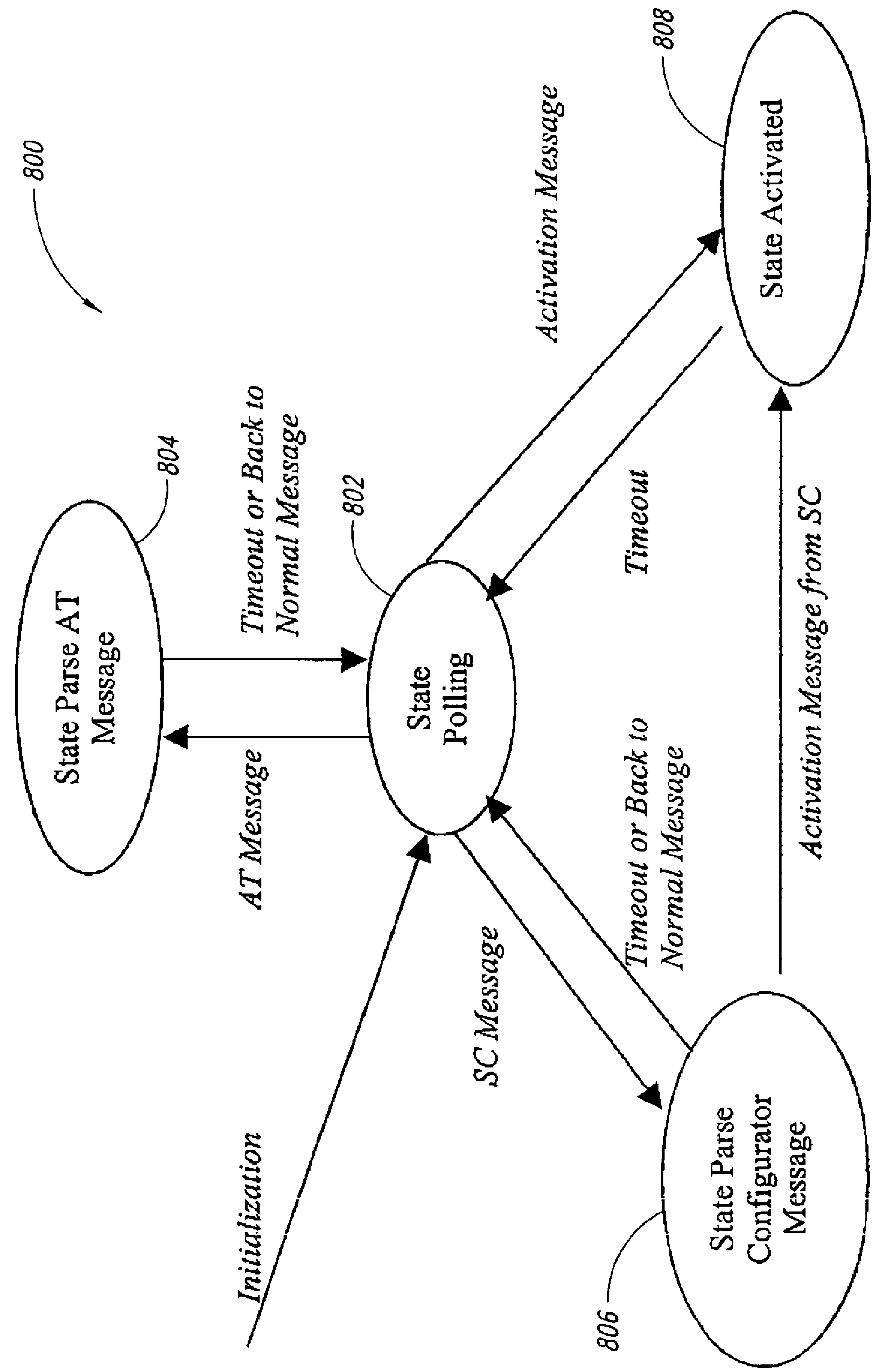
800
State Parse AT Message
804
State Polling
802
State Activated
808
State Parse Configurator Message
806
Initialization
AT Message
Timeout or Back to Normal Message
Activation Message
Timeout
SC Message
Timeout or Back to Normal Message
Activation Message from SC

FIG. 26

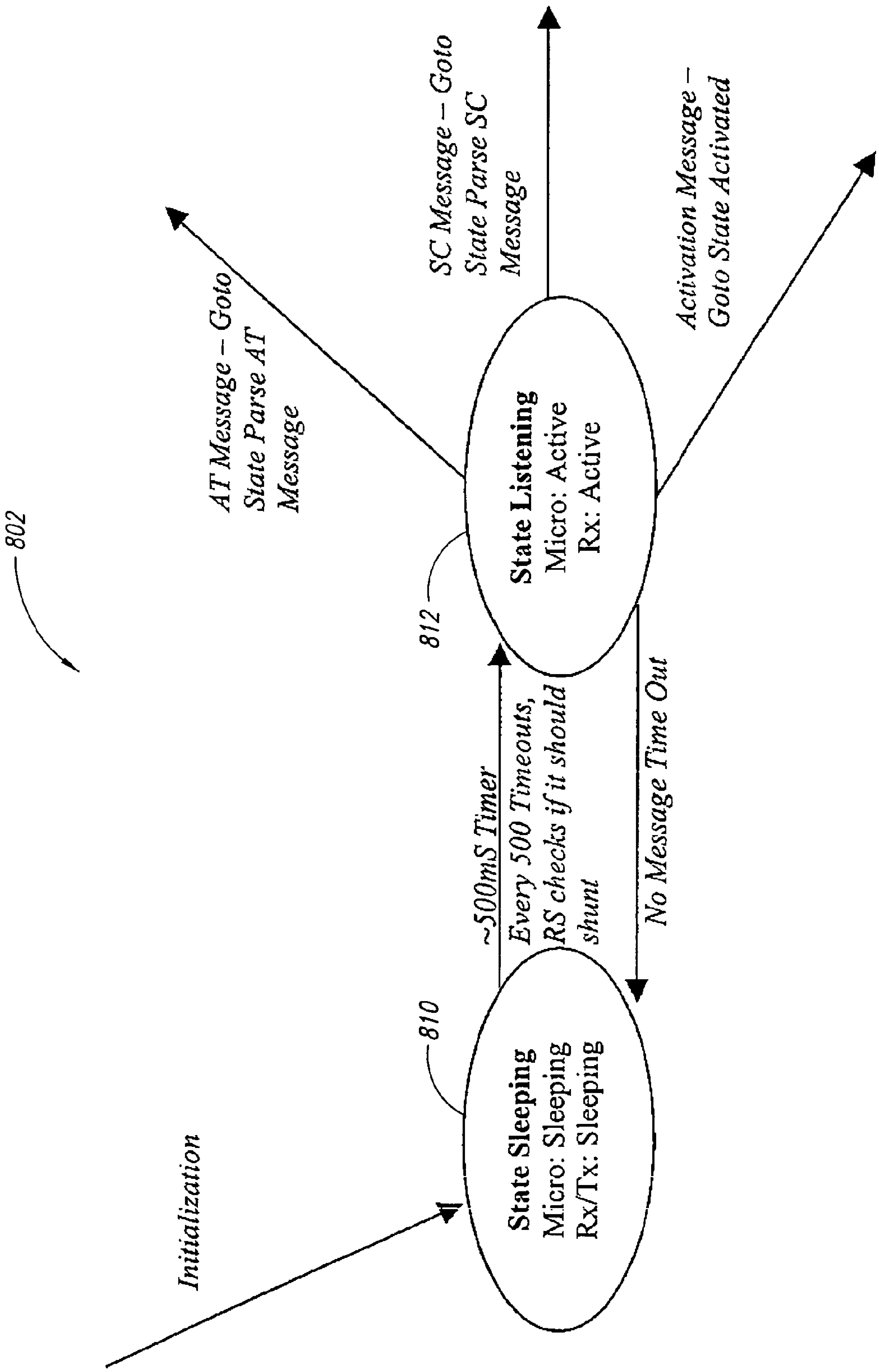
802
Initialization
810
State Sleeping
Micro: Sleeping
Rx/Tx: Sleeping
~500mS Timer
Every 500 Timeouts,
RS checks if it should
shunt
No Message Time Out
812
State Listening
Micro: Active
Rx: Active
AT Message – Goto
State Parse AT
Message
SC Message – Goto
State Parse SC
Message
Activation Message –
Goto State Activated

FIG. 27

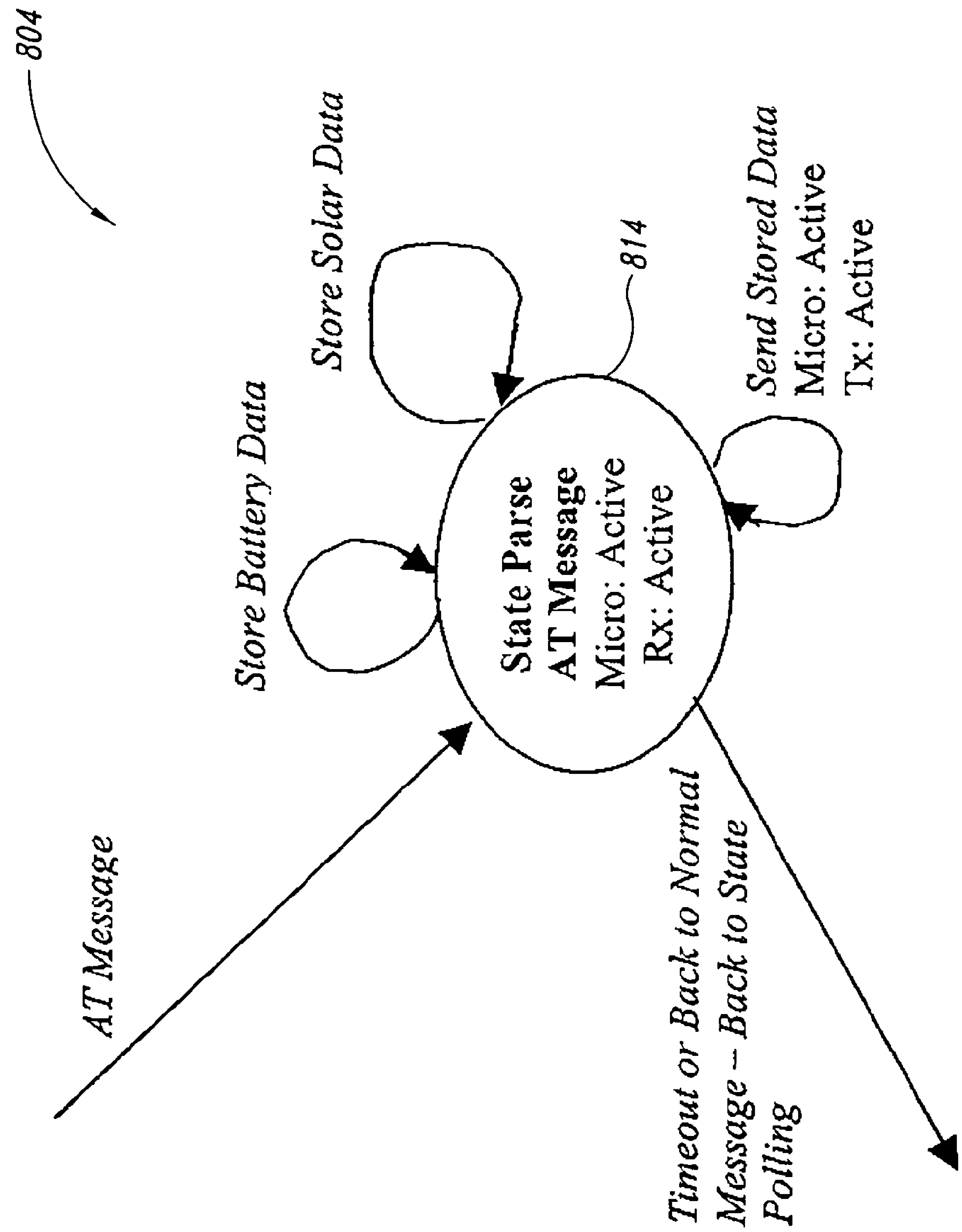
804
State Parse
AT Message
Micro: Active
Rx: Active
814
Store Battery Data
Store Solar Data
Send Stored Data
Micro: Active
Tx: Active
AT Message
Timeout or Back to Normal Message – Back to State Polling

FIG. 28

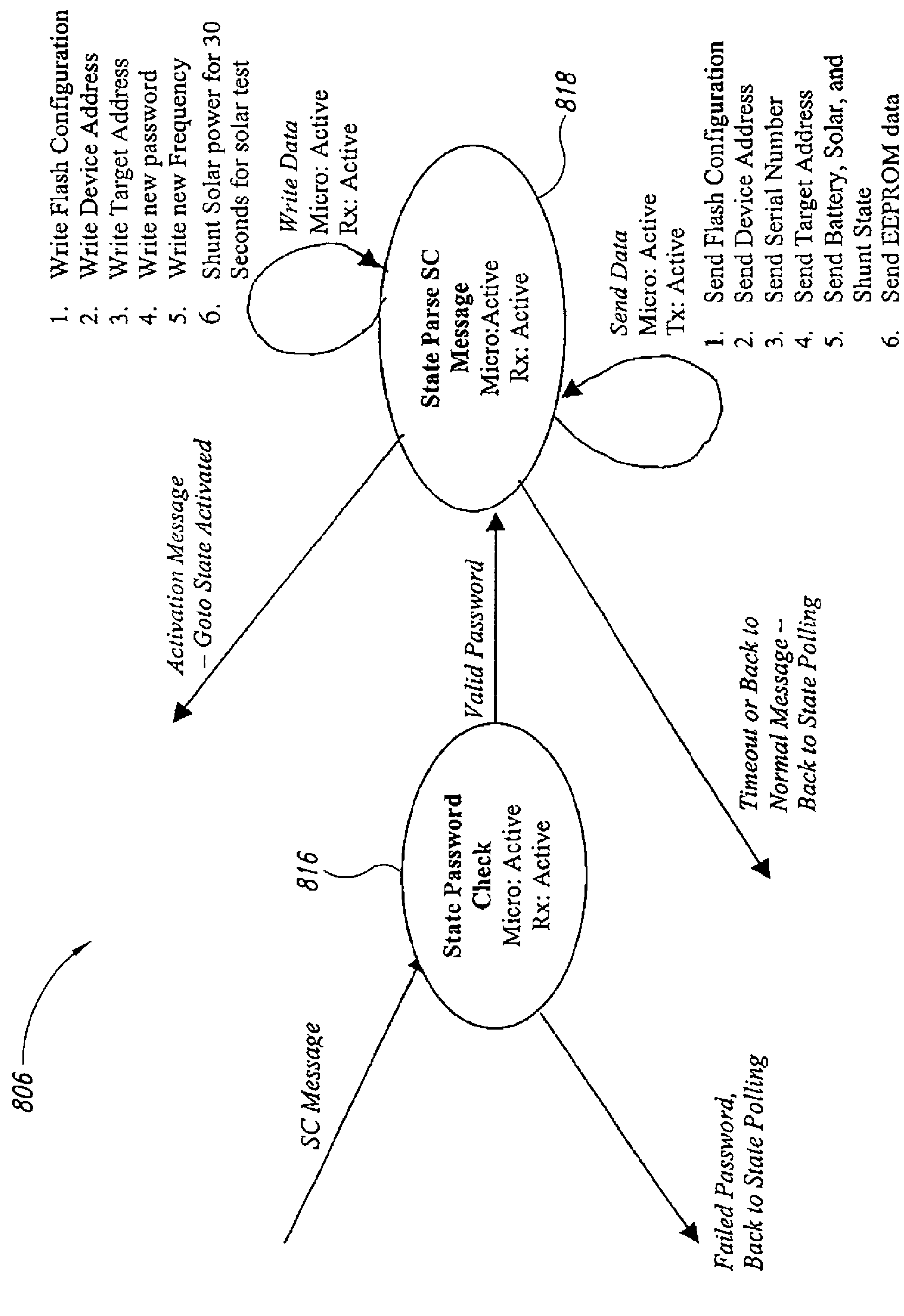
806
State Password Check
Micro: Active
Rx: Active
816
SC Message
Failed Password,
Back to State Polling
Valid Password
State Parse SC Message
Micro:Active
Rx: Active
818
Activation Message
– Goto State Activated
Timeout or Back to
Normal Message –
Back to State Polling
Write Data
Micro: Active
Rx: Active
1. Write Flash Configuration
2. Write Device Address
3. Write Target Address
4. Write new password
5. Write new Frequency
6. Shunt Solar power for 30 Seconds for solar test
Send Data
Micro: Active
Tx: Active
1. Send Flash Configuration
2. Send Device Address
3. Send Serial Number
4. Send Target Address
5. Send Battery, Solar, and Shunt State
6. Send EEPROM data

FIG. 29

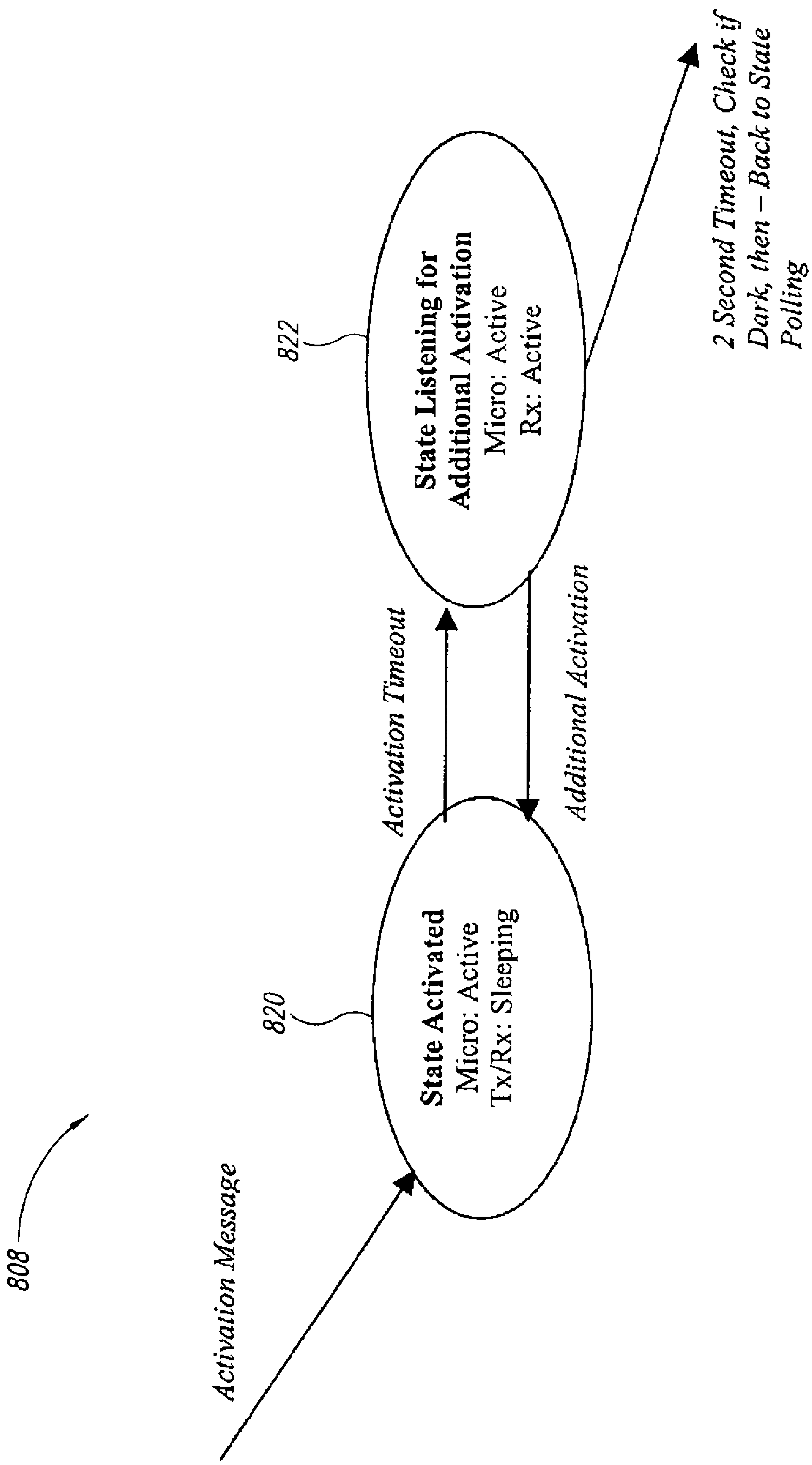
808
Activation Message
820
State Activated
Micro: Active
Tx/Rx: Sleeping
Activation Timeout
Additional Activation
822
State Listening for
Additional Activation
Micro: Active
Rx: Active
2 Second Timeout, Check if
Dark, then – Back to State
Polling

FIG. 30

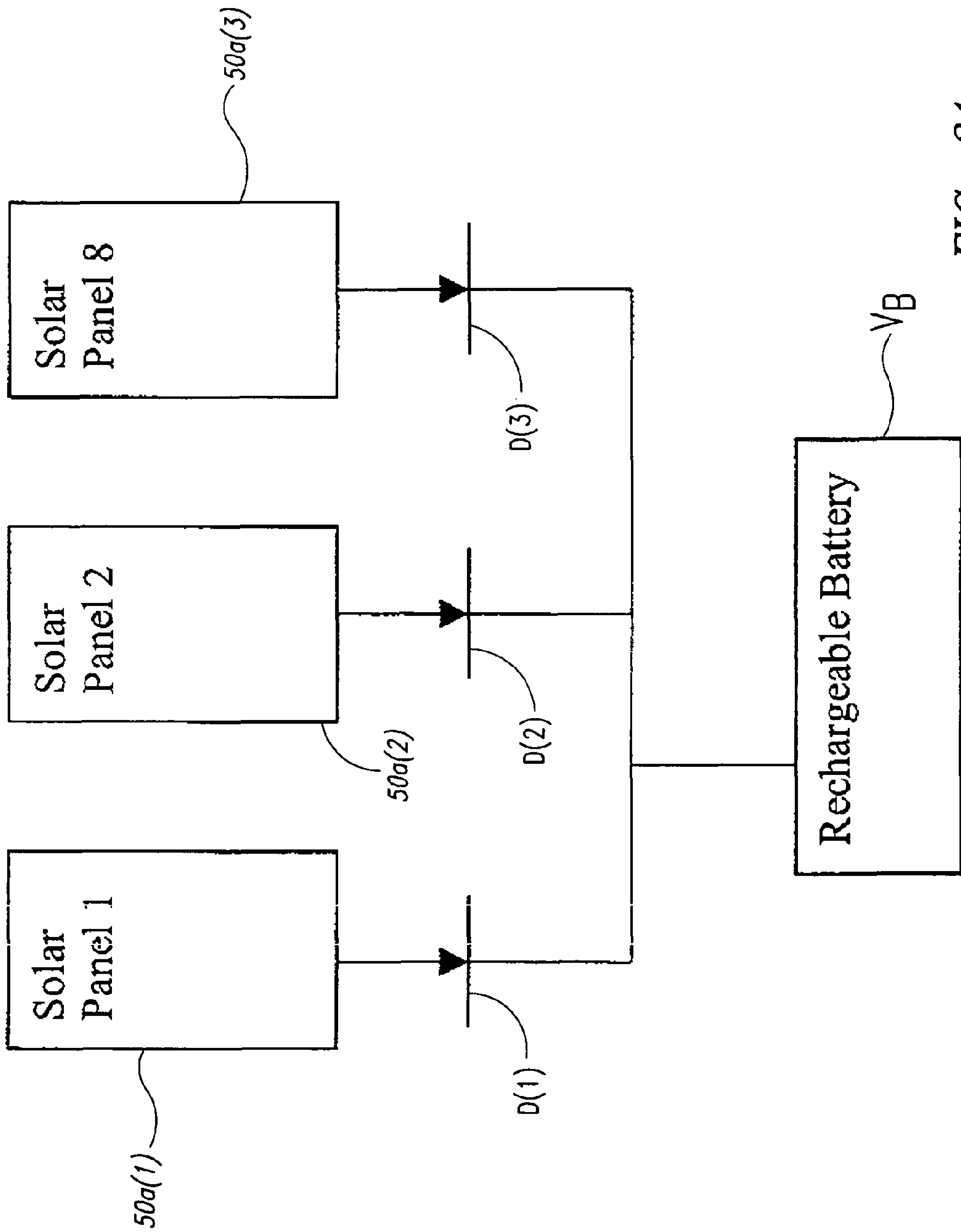
50a(3)
Solar Panel 8
D(3)
Solar Panel 2
50a(2)
D(2)
Solar Panel 1
50a(1)
D(1)
Rechargeable Battery
V_B

FIG. 31

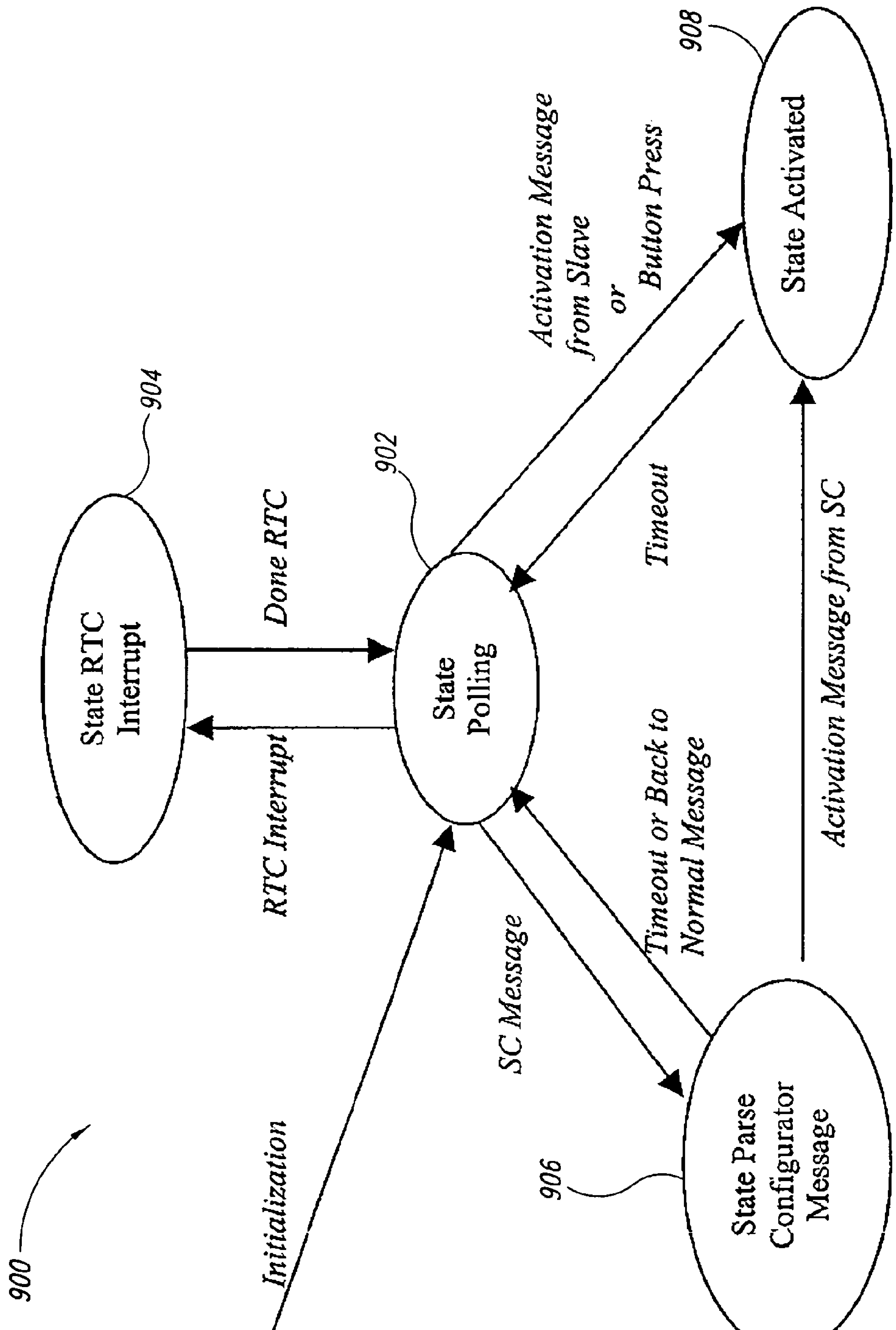
900
State RTC Interrupt
904
Done RTC
RTC Interrupt
State Polling
902
Initialization
SC Message
Timeout or Back to Normal Message
State Parse Configurator Message
906
Activation Message from Slave or Button Press
Timeout
State Activated
908
Activation Message from SC

FIG. 32

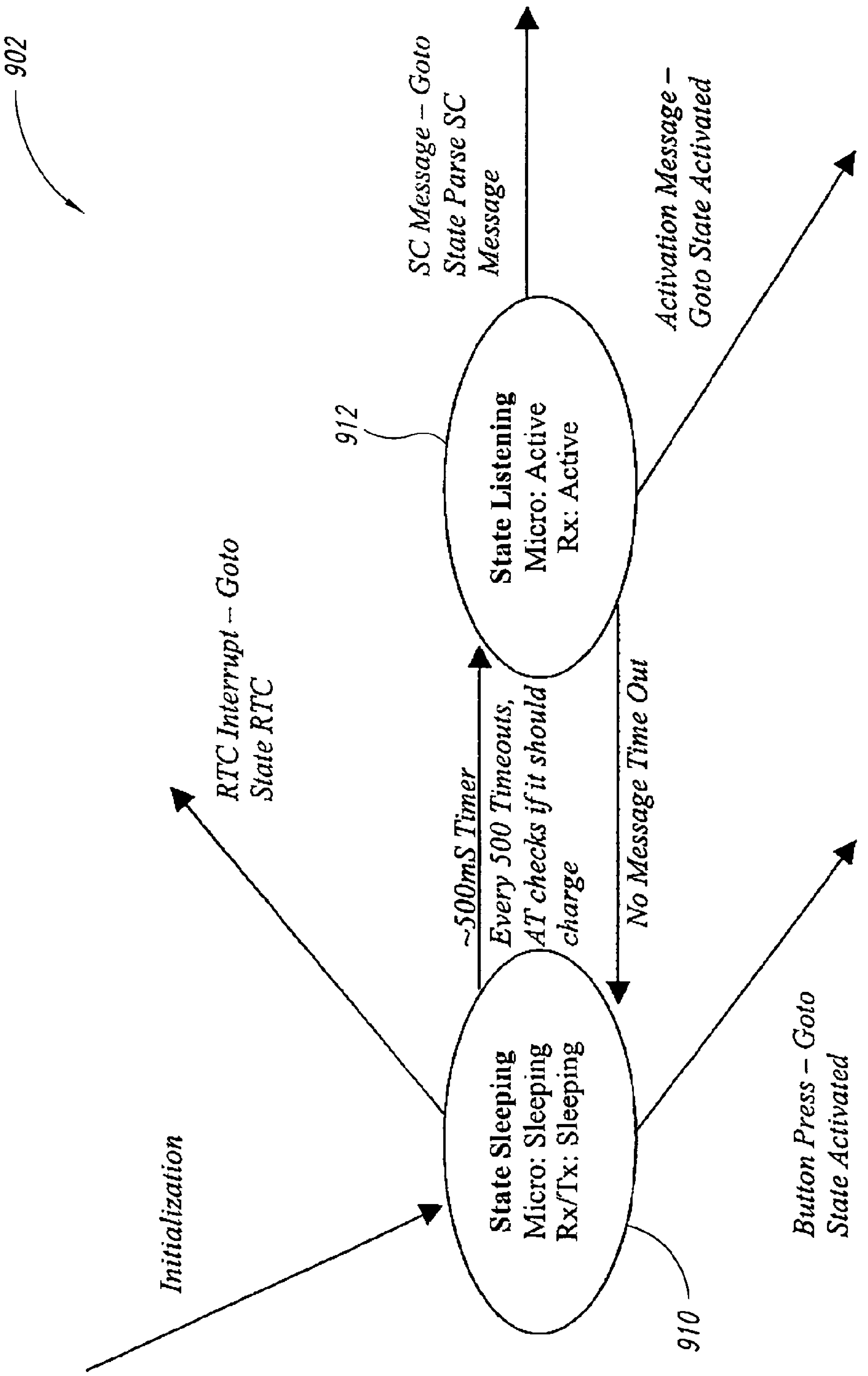
902
Initialization
State Sleeping
Micro: Sleeping
Rx/Tx: Sleeping
910
RTC Interrupt – Goto
State RTC
~500mS Timer
Every 500 Timeouts,
AT checks if it should
charge
No Message Time Out
Button Press – Goto
State Activated
State Listening
Micro: Active
Rx: Active
912
SC Message – Goto
State Parse SC
Message
Activation Message –
Goto State Activated

FIG. 33

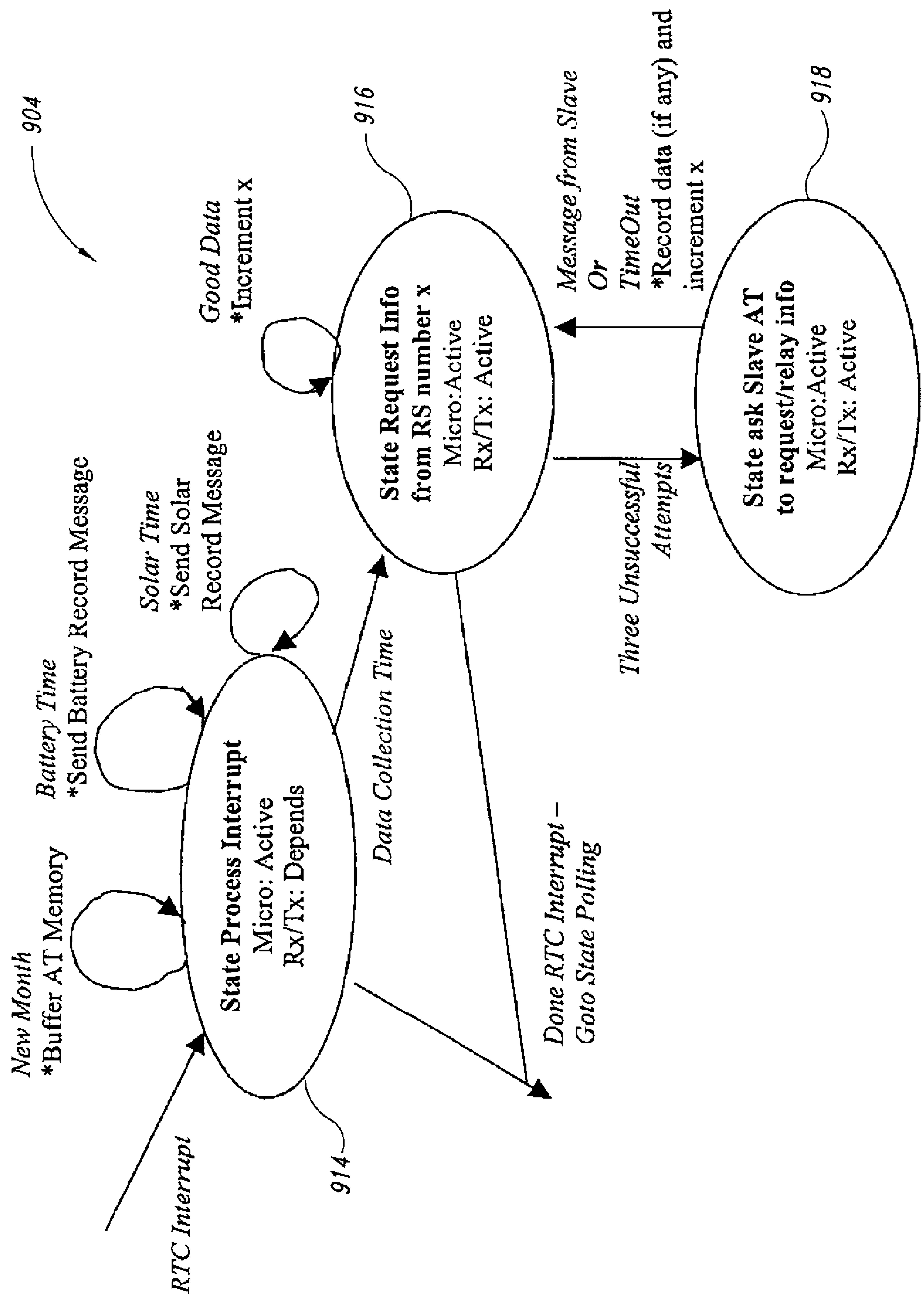
904
RTC Interrupt
New Month
*Buffer AT Memory
Battery Time
*Send Battery Record Message
Solar Time
*Send Solar
Record Message
State Process Interrupt
Micro: Active
Rx/Tx: Depends
914
Data Collection Time
Done RTC Interrupt –
Goto State Polling
Good Data
*Increment x
State Request Info
from RS number x
Micro:Active
Rx/Tx: Active
916
Three Unsuccessful
Attempts
Message from Slave
Or
TimeOut
*Record data (if any) and
increment x
State ask Slave AT
to request/relay info
Micro:Active
Rx/Tx: Active
918

FIG. 34

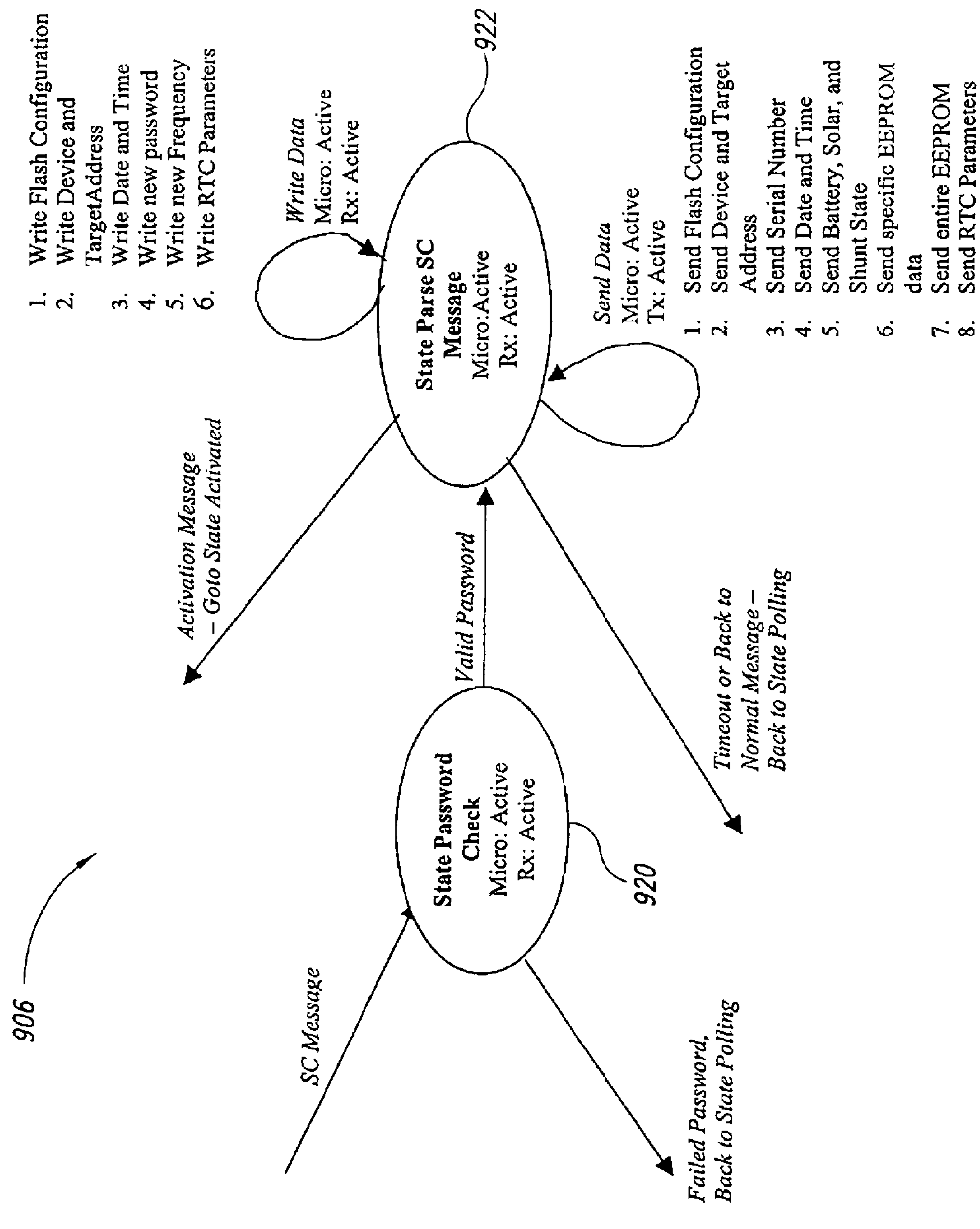
906
SC Message
State Password Check
Micro: Active
Rx: Active
920
Failed Password, Back to State Polling
Valid Password
Activation Message – Goto State Activated
Timeout or Back to Normal Message – Back to State Polling
State Parse SC Message
Micro:Active
Rx: Active
922
Write Data
Micro: Active
Rx: Active
1. Write Flash Configuration
2. Write Device and TargetAddress
3. Write Date and Time
4. Write new password
5. Write new Frequency
6. Write RTC Parameters
Send Data
Micro: Active
Tx: Active
1. Send Flash Configuration
2. Send Device and Target Address
3. Send Serial Number
4. Send Date and Time
5. Send Battery, Solar, and Shunt State
6. Send specific EEPROM data
7. Send entire EEPROM
8. Send RTC Parameters

FIG. 35

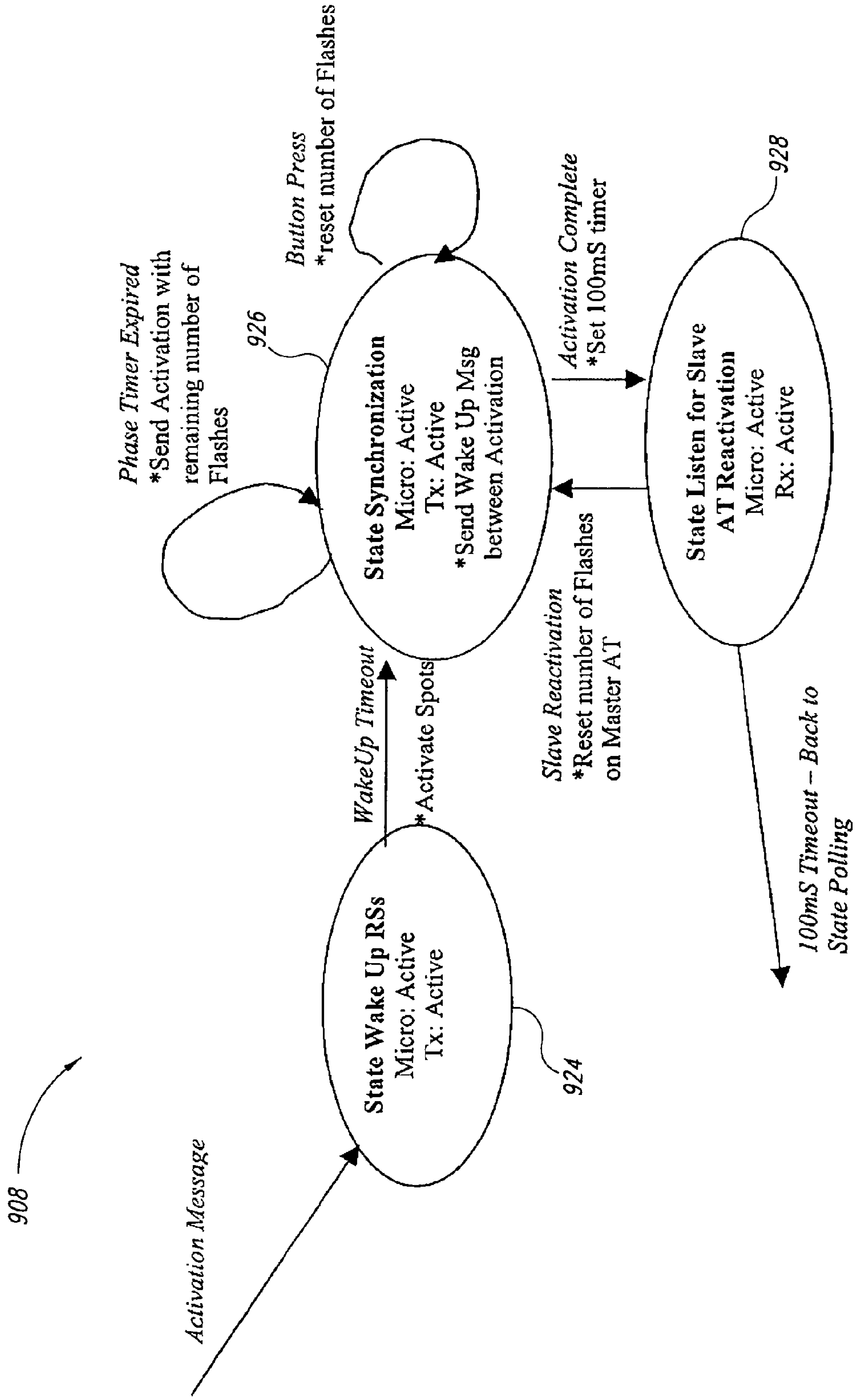
908
Activation Message
State Wake Up RSs
Micro: Active
Tx: Active
924
WakeUp Timeout
*Activate Spots
Phase Timer Expired
*Send Activation with remaining number of Flashes
926
State Synchronization
Micro: Active
Tx: Active
*Send Wake Up Msg between Activation
Button Press
*reset number of Flashes
Activation Complete
*Set 100mS timer
Slave Reactivation
*Reset number of Flashes on Master AT
928
State Listen for Slave AT Reactivation
Micro: Active
Rx: Active
100mS Timeout – Back to State Polling

FIG. 36

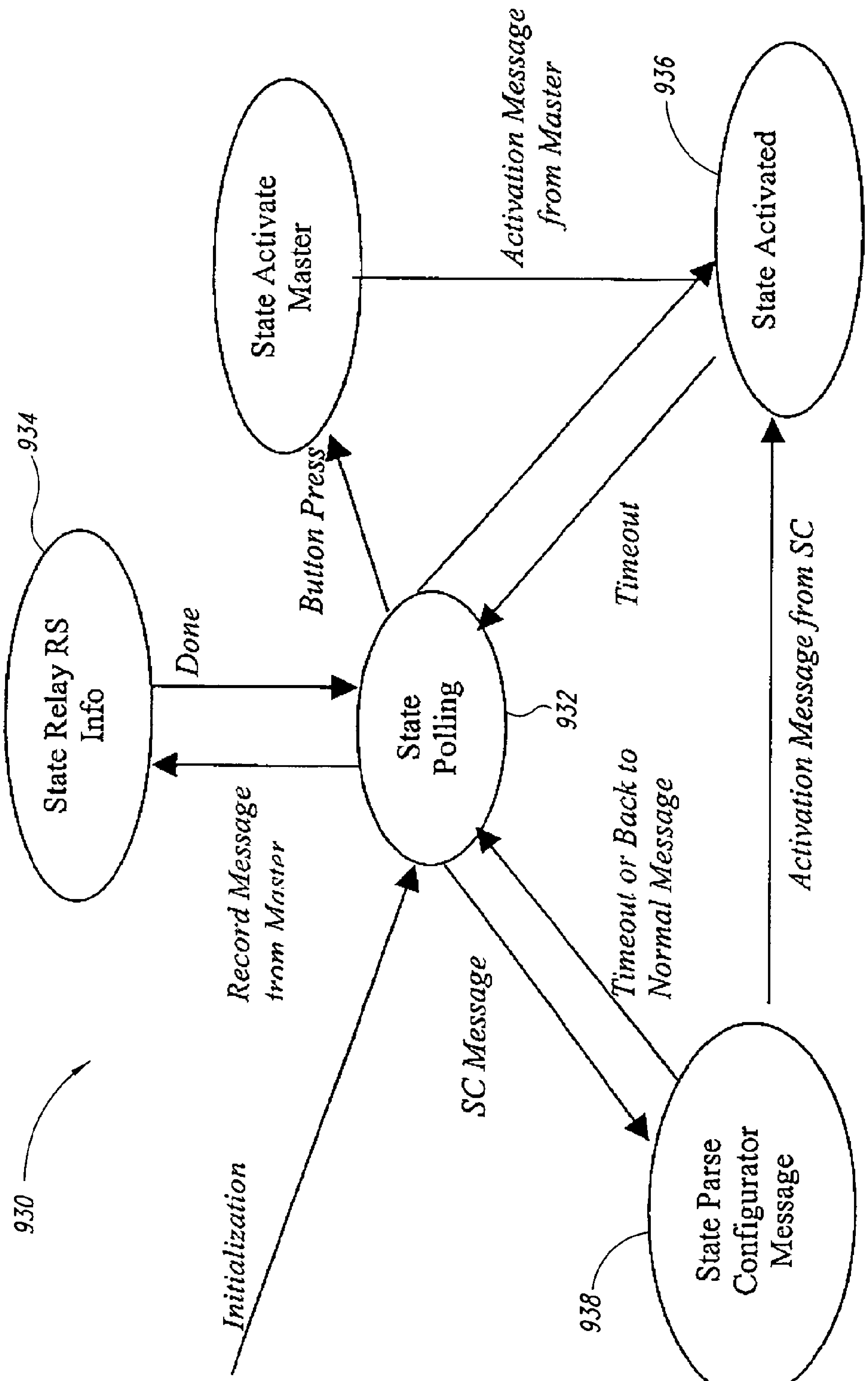
930
State Relay RS Info
934
State Activate Master
Activation Message from Master
936
State Activated
Done
Button Press
Record Message from Master
State Polling
932
Timeout
Initialization
SC Message
Timeout or Back to Normal Message
Activation Message from SC
State Parse Configurator Message
938

FIG. 37

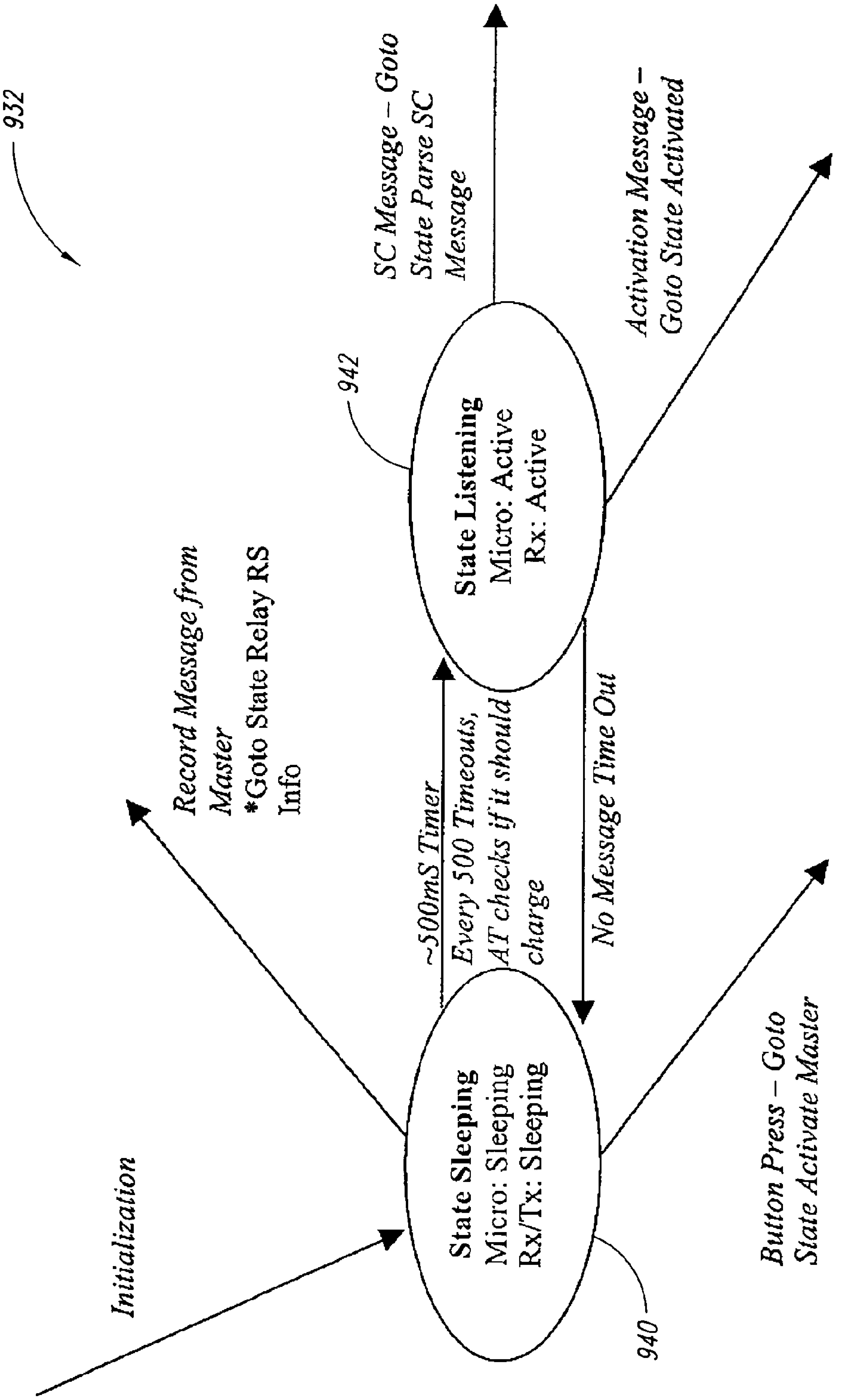
932
Initialization
State Sleeping
Micro: Sleeping
Rx/Tx: Sleeping
940
Record Message from Master
*Goto State Relay RS Info
~500mS Timer
Every 500 Timeouts, AT checks if it should charge
No Message Time Out
Button Press – Goto State Activate Master
State Listening
Micro: Active
Rx: Active
942
SC Message – Goto State Parse SC Message
Activation Message – Goto State Activated

FIG. 38

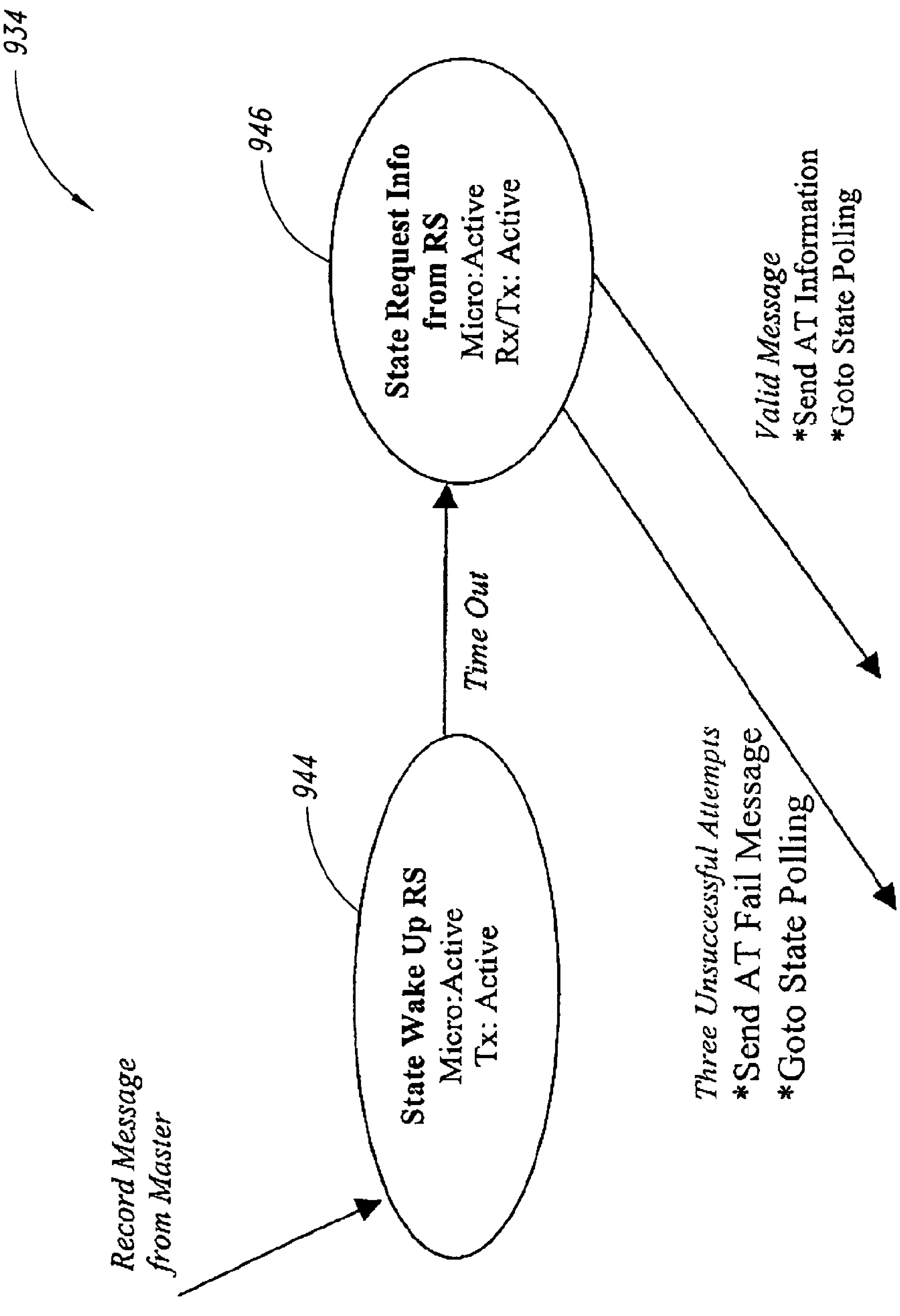
934
946
State Request Info from RS
Micro:Active
Rx/Tx: Active
944
State Wake Up RS
Micro:Active
Tx: Active
Record Message from Master
Time Out
Valid Message
*Send AT Information
*Goto State Polling
Three Unsuccessful Attempts
*Send AT Fail Message
*Goto State Polling

FIG. 39

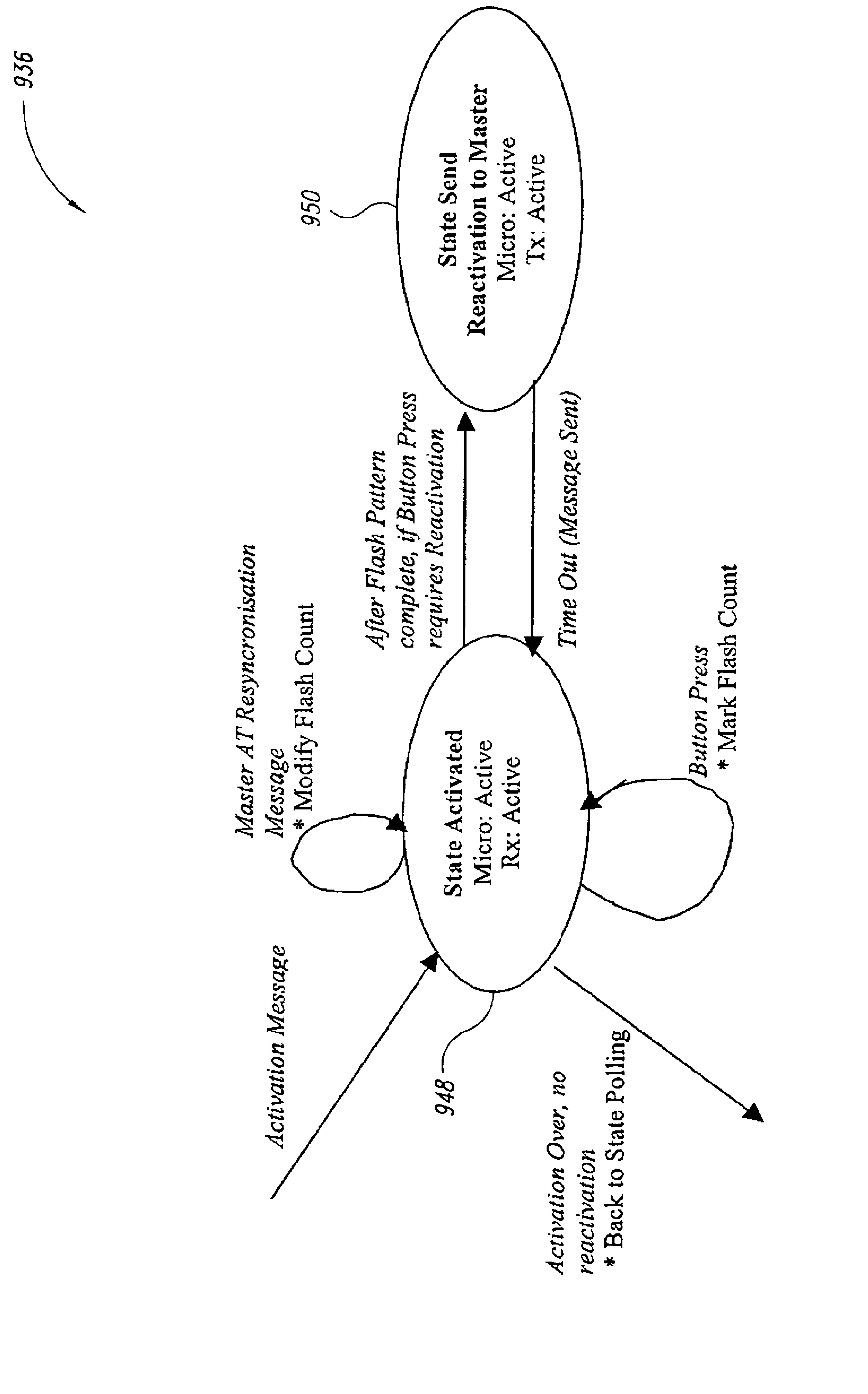
936
950
State Send Reactivation to Master
Micro: Active
Tx: Active
After Flash Pattern complete, if Button Press requires Reactivation
Time Out (Message Sent)
Master AT Resyncronisation Message
* Modify Flash Count
State Activated
Micro: Active
Rx: Active
Button Press
* Mark Flash Count
Activation Message
948
Activation Over, no reactivation
* Back to State Polling

FIG. 40

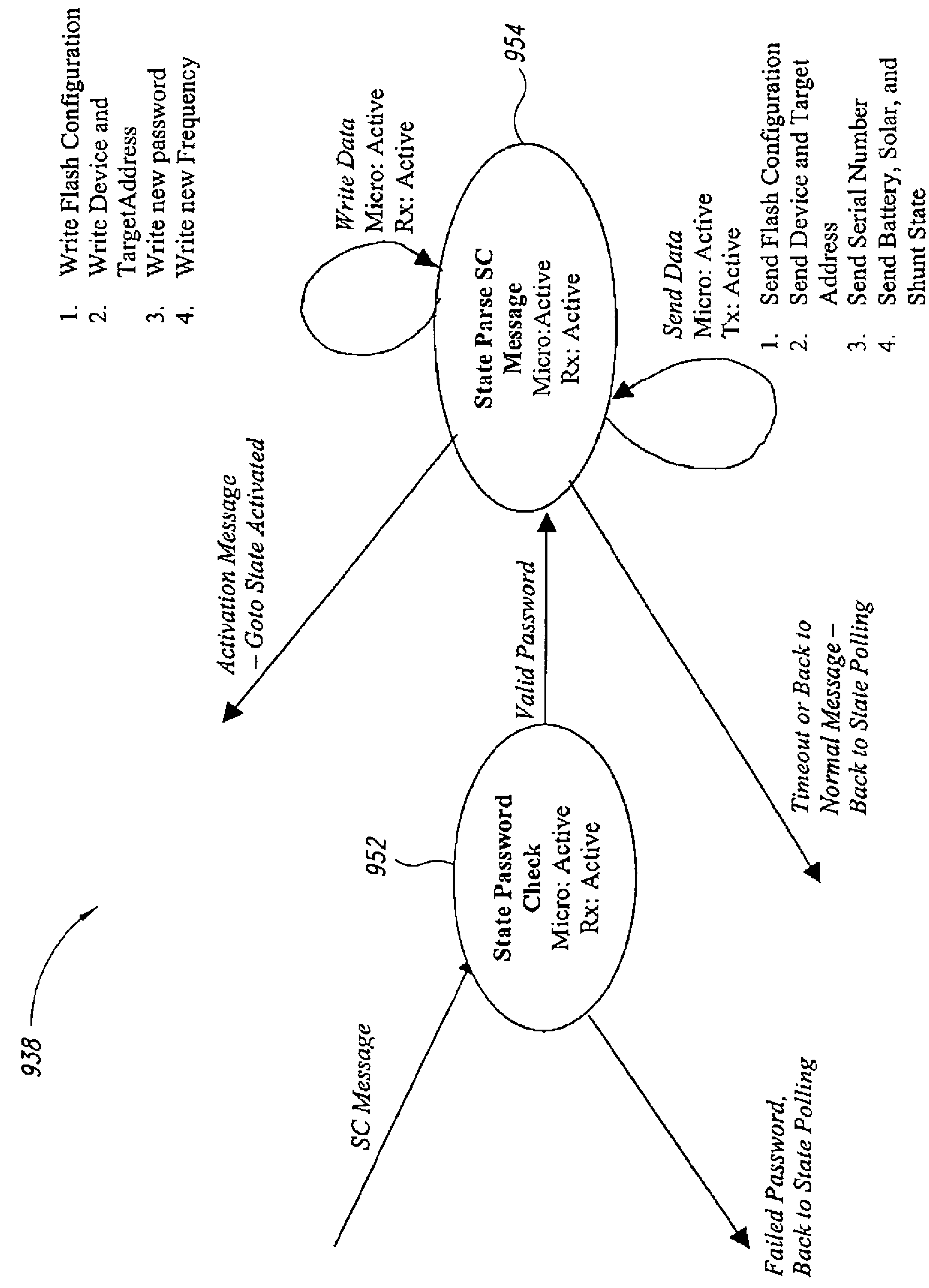
938
SC Message
952
State Password Check
Micro: Active
Rx: Active
Failed Password, Back to State Polling
Valid Password
954
State Parse SC Message
Micro:Active
Rx: Active
Write Data
Micro: Active
Rx: Active
1. Write Flash Configuration
2. Write Device and TargetAddress
3. Write new password
4. Write new Frequency
Send Data
Micro: Active
Tx: Active
1. Send Flash Configuration
2. Send Device and Target Address
3. Send Serial Number
4. Send Battery, Solar, and Shunt State
Activation Message – Goto State Activated
Timeout or Back to Normal Message – Back to State Polling

FIG. 41

METHODS, SYSTEMS AND DEVICES RELATED TO ROAD MOUNTED INDICATORS FOR PROVIDING VISUAL INDICATIONS TO APPROACHING TRAFFIC

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 11/055,558, filed Feb. 10, 2005, which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This disclosure relates to traffic safety and communication methods, systems and/or devices, specifically for advanced warning and notification to vehicular and pedestrian traffic.

2. Description of the Related Art

Prior approaches have employed a set of visual indicators mounted to a road to provide visual indications to approaching traffic.

For example, U.S. Pat. No. 4,570,207 teaches locating the visual indicators in apertures or channels formed in a road, such that a top surface of each of the visual indicators is flush with the top surface of the road. The visual indicators are formed with an exterior that wears away, in a similar fashion to the top surface of the road, to maintain the top surface of the visual indicators flush with the road.

Also for example, U.S. Pat. Nos. 6,384,742 and 6,597,293 teaches the placement of visual indicators at crosswalks and/or intersections. The indicators may be affixed or embedded in the roadway. The visual indicators may be activated by an activation device, for example, via a loop detector embedded in the road or other device that detects the approach of a vehicle. Alternatively, or additionally, the visual indicators may be activated by an activation device, for example, a manual switch such as a pedestrian operated push button, sensor, and/or conventional traffic timing mechanism. Power may be supplied via a utility grid, or from a photovoltaic array positioned on a pole adjacent the roadway.

Previous approaches employing road mounted visual indicators are inefficient, expensive and/or cumbersome. For example, providing power and/or communications typically requires the laying of wires or cable along or underneath the road, a sidewalk, and/or an area adjacent the road. Such often requires trenching across an entire length or width of the road. For example, prior approaches typically require digging up large portions of the road, sidewalk and/or adjacent areas, via trenching or saw-cutting. In addition to trenching of the road to create locations for mounting the visual indicators, previous approaches require additional trenching in order to provide power and/or communications. Thus, additional trenching is required to provide power to the visual indicators from an existing power producing source, typically located along a curb or street. Additionally trenching may also be required to provide power to the activation device (e.g., loop sensor, other sensor, manually activated button, etc.). Further, additional trenching may be required to provide communications between the activation device and the road mounted visual indicators.

Such prior approaches typically also require the installation of a costly transformer box to transform power from a higher voltage (e.g., 110V or 240V provided by a utility grid) to a smaller voltage amount (e.g., 12 volts) for use by the road mounted visual, or by the activation devices.

Despite market demand, no known previous approach has successfully addressed these issues. Know approaches have also failed to adequately address minimizing power consumption while maximizing efficiency and sensory output. Thus, prior approaches miss a very high percentage, such as 90%, of potential implementations for in-surface devices, due to concerns over cost and/or inconvenience.

BRIEF SUMMARY OF THE INVENTION

Road mounted visual indicator devices for use in commercial, private, and/or public sector use garner significant market demand with respect to addressing issues surrounding traffic safety and enhanced signaling of information. While prior approaches include hard-wired devices, they present no functional path or detail to overcoming real-world power and communication issues. The approach described herein offers novel physical and mechanical differences which provide the means and methodology to meet a variety of stringent operational and regulatory needs, while being completely standalone for long periods of time encompassing several years. The approach used for these developments is unobvious, as it does not yet exist in any commercially available form relating to invention's market. It has been a long felt but unsolved need until development of invention, with the failure of previous efforts. This present approach overcomes these seeming liabilities with a series of developments and unappreciated advantages that solve prior inoperability concerns.

In one aspect, A traffic visual indicator device for mounting to a surface of a road that carries traffic in at least a first direction comprises: a housing comprising a base and at least a first face extending generally upward from the base; a power producing source carried by the housing and operable to produce power; a first illumination source carried by the housing and positioned to transmit light out from the first face of the housing toward the traffic in a second direction generally opposed to the first direction when the traffic visual indicator device is mounted to the surface of the road; a circuit carried by the housing, electrically coupling the power producing source and the first illumination source, the circuit operable to selectively supply power from the power producing source to the first illumination source; and a wireless communications subsystem carried by the housing and operable to at least receive wireless communications from an external source remotely spaced from the housing.

In another aspect, a method of providing information to traffic moving along a road in at least a first direction comprises: producing power from a respective integral power producing source at each of a number of traffic visual indicator devices mounted to a surface of a road that carries traffic; wirelessly receiving information by at least a first one of the traffic visual indicator devices, the wirelessly received information from an external device remotely located with respect to at least the first one of the number of traffic visual indicator devices; and transmitting light from at least one of the number of traffic visual indicator devices toward the traffic, in a direction generally opposed to the first direction based at least in part on the wirelessly received information.

In a further aspect, a traffic informational system for providing information to traffic moving along a road in at least a first direction comprises: a plurality of traffic information devices mountable to the road, each of the traffic information devices, comprising: a housing comprising a base; a power producing source carried by the housing, the power producing source operable to produce power; a first illumination source carried by the housing, the first illumination source operable to transmit light out of the housing generally toward on-coming traffic when the traffic visual indicator device is mounted to the road; a circuit carried by the housing, the circuit operable to selectively supply power from the power producing source to at least the first illumination source; and a wireless communications subsystem carried by the housing and operable to at least receive wireless communications externally from the housing. The traffic informational system may further comprise at least a first external control device comprising at least one antenna and a transmitter coupled to the antenna and operable to transmit wireless communications to at least a first one of the plurality of traffic information devices.

In some aspects, small, self-powered road mounted visual indicators may be used in providing surface lighting, mounted lighting, in-roadway communication and ambient condition sensing.

In another aspect, a traffic information system and/or visual indicator devices realize low power consumption, utilizing power modulation, signaling, and coding techniques to minimize the typical power consumption associated with wireless communications, while providing full functionality.

In another aspect, a traffic information system and/or visual indicator devices allows for dynamic configuration and operation. Design and operational parameters may be updated based on wirelessly receives signals and/or self-detected information from ambient environment. Visual indicator devices may process information, and store commands, programming, and configurations; allowing each device to be an interactive and dynamic component of its environment.

In another aspect, a traffic information system and/or visual indicator devices may be programmed in real-time or pre-programmed. An "intelligent" ability to process information from the ambient environment, allows devices to communicate based upon realtime events surrounding in the environment or based on wireless communications to device, as well as, pre-programmed commands based upon various constraints including time of day, type of weather, proximity and/or type of stimuli, etc.

In another aspect, a traffic information system and/or visual indicator devices provides wireless interference mitigation capabilities, for example, proactively checking for interference in wireless signaling, allowing frequent minor changes in frequency to overcome congestion or distortion issues. This not only may improve reliability, but also may improve the integrity for sending data, images, and commands as well as receiving data, images, and commands.

In another aspect, a traffic information system and/or visual indicator devices employ reliable self-power. A flow valve and energy control sensor controls the power supply for operation of visual indicator device, selecting a rechargeable power supply when power storage levels are high or a high density, long lasting, non-rechargeable power supply when power levels are low. This allows the visual indicator device to build up power reserves through use of a self power apparatus, such as solar panels, providing continuous power for long periods.

In another aspect, a traffic information system and/or visual indicator devices are long lasting. Power management allows each visual indicator device to last for several years, making the device's durability and life constrained more by physical structure rather than electrical efficiency.

In another aspect, a traffic information system and/or visual indicator devices employ brightness control. A control sensor that continually checks the brightness levels in ambient environment allows the controlling of the optical emission of each visual indicator device. Thus, one option is that when it is darker in device's surroundings, a lower intensity optical brightness level may be used, as a more intense or brighter level may be used during times of greater light in device's environment. By performing this unique control mechanism, the efficiency of the visual indicator devices may be improved while also responding directly to improving the observable effect of device, thereby improving its effectiveness and safety.

In another aspect, a traffic information system and/or visual indicator devices employ audio control. A control sensor checks the ambient noise in device's environment, and the visual indicator devices modify the audio output based on the ambient noise. Thus, one option may be to increase the audio output during periods of high background or ambient noise while lowering audio output for periods of normal or low background or ambient noise. This approach seeks to improve devices audio notification and sensory messaging, thereby improving effectiveness and subsequent safety.

In another aspect, a traffic information system and/or visual indicator devices is flexible. Many unappreciated advantages and functions allow the traffic information system and/or visual indicator devices to be used in areas with insufficient or no power. The traffic information system and/or visual indicator devices may be used in a plethora of previously long felt but unrealized locations, needs, and uses. Due to the many advantages, previous inoperability in many of these environments is no long an issue.

In another aspect, a traffic information system and/or visual indicator devices are easy to maintain and replace, if necessary. A special anchoring mechanism may be used that is mounted in or on the road, allowing visual indicator devices to be removably mounted to the anchoring mechanism with one or more types of mounting apparatus such as screws, locks, or brackets for quick and convenient installation and removal.

In another aspect, a traffic information system and/or visual indicator devices provides for device status reporting. A specialized reporting option provides for the proactive management of each visual indicator device by sending notification of operational information such as battery charge levels, previous average solar absorption rates, and ratios of activation attempts to flashing cycles, etc. The approach provides proactive management capabilities to site maintenance, providing information regarding exactly how each visual indicator device is performing, and permitting the changing or replacing units well in advance of need.

In another aspect, a traffic information system and/or visual indicator device provides reporting tools. A variety of reporting tools and/or options may be provided to administrators of from usage information to proactive notification of problems or communication errors. The content and format of said reporting provides a variety of usage information which can be used for a variety of needs, such as to show implementers how many times each traffic information system is used, allowing them to better gauge future traffic patterns and improve overall traffic safety.

Additional aspects and advantages will be apparent upon consideration of the ensuing drawings and description.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

In the drawings, identical reference numbers identify similar elements or acts. The sizes and relative positions of elements in the drawings are not necessarily drawn to scale. For example, the shapes of various elements and angles are not drawn to scale, and some of these elements are arbitrarily enlarged and positioned to improve drawing legibility. Further, the particular shapes of the elements as drawn, are not intended to convey any information regarding the actual shape of the particular elements, and have been solely selected for ease of recognition in the drawings.

FIG. **1** is a schematic view of an environment showing a road carrying traffic in at least one direction proximate a pedestrian crosswalk, and a traffic information system comprising a number of road mounted traffic visual indication devices providing visual indications and a number of activation devices located proximate the road but remotely from the traffic visual indication devices, according to one illustrated embodiment.

FIG. **2** is a top plan view of a traffic visual indication device according to one illustrated embodiment, showing a first set of visual indicators, an array of photovoltaic cells, an antenna, and an audio transducer.

FIG. **3** is a top plan view of a traffic visual indication device according to another illustrated embodiment, showing a second set of visual indicators opposed to the first set of visual indicators.

FIG. **4** is a schematic diagram of the traffic visual indication device of FIG. **3**, showing a number of throughholes for receiving fasteners to mount the traffic visual indication device to an anchor mechanism.

FIG. **5** is a front elevational view of a traffic visual indication device of FIGS. **3** and **4**, showing an anchoring mechanism comprising a base plate and elongated fluted extending from the base plate according to one illustrated embodiment, and further showing a fastener received through one of the throughholes.

FIG. **6** is a schematic view of the environment of FIG. **1**, showing wireless communications between the traffic visual indication devices and/or remotely located activation devices.

FIG. **7** is a partially exploded view of a traffic visual indication device.

FIG. **8** is an isometric view of a base of the traffic visual indication device showing an anchoring mechanism according to another illustrated embodiment.

FIGS. **9**A-**9**D are an electrical schematic diagram of the circuitry of a traffic visual indication device, according to one illustrated embodiment.

FIG. **10** is a schematic diagram of the traffic information system illustrating communications between traffic visual indicator devices, activation devices, and a full-featured software configuration tool, according to one illustrated embodiment.

FIG. **11** is a schematic diagram of the traffic visual indicator device showing communications between various subsystems and/or element thereof, according to one illustrated embodiment.

FIG. **12** is a schematic diagram of an activation device showing interaction between a controller, wireless transceiver, power storage devices, power regulating circuit and power producing source, according to one illustrated embodiment.

FIG. **13** is a schematic diagram of a software configuration tool according to one illustrated embodiment.

FIG. **14** is a schematic diagram of a road and a transit stop, employing traffic visual indicator devices according to one illustrated embodiment.

FIG. **15** is a schematic diagram of a road and hydrants, employing traffic visual indicator devices according to one illustrated embodiment.

FIG. **16** is a schematic diagram of a road with overhead lighting, employing traffic visual indicator devices according to one illustrated embodiment.

FIG. **17** is a schematic diagram of road including an obstruction such as snow, employing traffic visual indicator devices according to one illustrated embodiment.

FIG. **18** is a schematic diagram of a two roads carrying traffic in generally opposed directions and a turnaround road or area, employing traffic visual indicator devices according to one illustrated embodiment.

FIG. **19** is a schematic diagram of a six lane road, including a number of reversible lanes, employing traffic visual indicator devices according to one illustrated embodiment.

FIG. **20** is a flowchart showing a method of installing a traffic visual indicator device on a road, according to one illustrated embodiment.

FIG. **21** is a flowchart showing a high level method of operating a traffic visual indicator device, according to one illustrated embodiment.

FIG. **22** is a flowchart showing a method of low level method of operating a traffic visual indicator device to wirelessly receive and/or transmit information, according to one illustrated embodiment.

FIG. **23** is a flowchart showing a method of operating a traffic information system to detect and announce the arrival of a vehicle, for example a public transportation vehicle, according to one illustrated embodiment.

FIG. **24** is a flowchart showing a method of operating a traffic information system to detect and announce a speed of one or more vehicles, according to one illustrated embodiment.

FIG. **25** is a flowchart showing a method of operating an activation device, according to one illustrated embodiment.

FIG. **26** is a schematic diagram of an overall state machine implementing the functionality of a traffic visual indicator device of a traffic information system, according to one illustrated embodiment.

FIG. **27** is a schematic diagram of a state machine implementing a polling state of the state machine of FIG. **26**, according to one illustrated embodiment.

FIG. **28** is a schematic diagram of a state machine implementing an activation message parsing state of the state machine of FIG. **26** to parse an activation message received from an activation device, according to one illustrated embodiment.

FIG. **29** is a schematic diagram of a state machine implementing a configuration message parsing state of the state machine of FIG. **26** to parse a configuration message received from another traffic visual indication device, according to one illustrated embodiment.

FIG. **30** is a schematic diagram of a state machine implementing an activated state of the state machine of FIG. **26**, according to one illustrated embodiment.

FIG. **31** is a schematic diagram of a number of groups of photovoltaic cells coupled by respective diodes to at least one energy storage device, according to one illustrated embodiment.

FIG. **32** is a schematic diagram of an overall state machine implementing the functionality of a master activation device of a traffic information system, according to one illustrated embodiment.

FIG. **33** is a schematic diagram of a state machine implementing a polling state of the state machine of FIG. **32**, according to one illustrated embodiment.

FIG. **34** is a schematic diagram of a state machine implementing an RTC interrupt state of the state machine of FIG. **32**, according to one illustrated embodiment.

FIG. **35** is a schematic diagram of a state machine implementing a parsing state of the state machine of FIG. **32**, according to one illustrated embodiment.

FIG. **36** is a schematic diagram of a state machine implementing an activated state of the state machine of FIG. **32**, according to one illustrated embodiment.

FIG. **37** is a schematic diagram of an overall state machine implementing the functionality of a slave activation device of a traffic information system, according to one illustrated embodiment.

FIG. **38** is a schematic diagram of a state machine implementing a polling state of the state machine of FIG. **37**, according to one illustrated embodiment.

FIG. **39** is a schematic diagram of a state machine implementing a relay traffic visual indicator device information state of the state machine of FIG. **37**, according to one illustrated embodiment.

FIG. **40** is a schematic diagram of a state machine implementing an activated state of the state machine of FIG. **37**, according to one illustrated embodiment.

FIG. **41** is a schematic diagram of a state machine implementing a parsing state of the state machine of FIG. **37**, according to one illustrated embodiment.

DETAILED DESCRIPTION

In the following description, certain specific details are set forth in order to provide a thorough understanding of various disclosed embodiments. However, one skilled in the relevant art will recognize that embodiments may be practiced without one or more of these specific details, or with other methods, components, materials, etc. In other instances, well-known structures associated with transmitters, receivers, transceivers, charging circuits, power conditioning circuits, processors and/or controllers, and the like have not been shown or described in detail to avoid unnecessarily obscuring descriptions of the embodiments.

Unless the context requires otherwise, throughout the specification and claims which follow, the word "comprise" and variations thereof, such as, "comprises" and "comprising" are to be construed in an open, inclusive sense, that is as "including, but not limited to."

Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, the appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

The headings provided herein are for convenience only and do not interpret the scope or meaning of the embodiments.

FIG. **1** shows an environment **10***a* including a road **12** having a surface **14**, that carries traffic **16** in at least a first direction indicated by arrow **18**. The particular illustrated location is a crosswalk **20**, which may be marked or unmarked for example by stripes. However, the teachings herein are applicable to other locations along a road, such as an intersection, median, exit, or entrance. As used herein and in the claims the term road means any road, street, highway, freeway, turnpike, rail, roadbed, taxiway, runway or other vehicular traffic bearing medium.

A traffic information system **22** comprises a number of traffic visual indicator devices **24***a*-**24***i* mounted to the road **12**, and a number of activation devices **26***a*, **26***b* located remotely from the traffic visual indicator devices **24***a*-**24***i*.

A number of the traffic visual indicator devices **24***a*-**24***f* may be positioned partially extending across the road **12** on both sides of the crosswalk **20**. One or more of the traffic visual indicator devices **24***g*, **24***h* may be positioned to provide an advanced warning to traffic **16**, being spaced upstream of a traffic flow from the crosswalk **20**. One or more of the traffic visual indicator devices **24***i* may be positioned and/or oriented to provide a lighted indication to pedestrian traffic, for example, crossing at the cross walk perpendicular the general orientation of the road.

The activation devices **26***a*, **26***b* may be located proximate the road **12**, for example, on a bicycle path or sidewalk **28***a*, **28***b*, and may or may not be mounted on a pole **30***a*, **30***b*. In at least one embodiment, the activation devices **26***a*, **26***b* may comprise push button **32***a* mounted on the pole **30***a*. As discussed in detail below, one or more of the activation devices **26***a*, **26***b* may include a wireless communications subsystem that communicates (e.g., broadcasts or pointcasts) with one or more of the traffic visual indicator devices **24***a*-**24***i*, for example to provide information regarding a dynamic criteria or criterion such as a pedestrian pushing a button.

FIG. **2** shows one of the traffic visual indicator devices **24***a*-**24***i* (collectively referred to as **24**) according to one illustrated embodiment. The traffic visual indicator device **24** comprises a housing **34** including a base **36** designed to be affixed or mounted to the road **12** or an anchoring mechanism **58** (discussed below). The housing **34** may also include a top **38**, comprising a clear structural support mechanism with sufficient rigidity and strength the protect components within the housing **34** when the traffic visual indicator device **24** struck by traffic **16** such as a vehicle such as a truck, bus, automobile, motorcycle, bicycle, train, plane. The top **38** of the housing **34** may be made from one or more materials including metal, metal composite, carbon fiber, synthetic, or organic based materials, and may be designed to support, for example, 15 metric tons of weight.

The housing **34** may further comprise a first face **40***a*, and a second face **40***b* opposed to the first face **40***a*. In use, the traffic visual indicator devices **24** may be mounted to the road **12** such that the first face **40***a* faces the direction from which traffic **16** is approaching. Where the road **12** carries traffic in two, opposed directions, each of the first and second faces **40***a*, **40***b* will thus face approaching traffic **16**. One or more of the faces **40***a*, **40***b* may form an acute angle with the base **36**, which may facilitate the passing of traffic **16** over the traffic visual indicator devices **24**.

The traffic visual indicator device **24** comprises one or more illuminations sources. For example, a first set of illuminations sources **42***a* are positioned to project light out from the first face **40***a* of the housing.

As illustrated in FIG. **3**, the traffic visual indicator device **24** may include a second set of illumination sources **42***b* to project light out from the second face **40***b* of the housing **34**. The light from the second set of illuminations sources **42***b* would generally be projected in the direction indicated by arrow **18** (FIG. **1**), that is toward a flow of traffic coming from an opposite direction from the traffic **16** illustrated in FIG. **1**. Thus, the embodiment of FIG. **3** would be particularly useful where the road **12** carries traffic in two opposing directions. Alternatively, or additionally, reflectors or retro-reflectors **44** may be positioned along or beneath one or more faces, such as best illustrated in FIG. **2**.

With reference to FIGS. **2** and **3**, the illumination sources **42***a*, **42***b* may, for example, comprise one or more light emitting diodes (LEDs) **46** (only three called out in the Figures) and may include one or more optical components (not shown) such as simple or compound lenses for focusing emitted light, and/or one or more mirrors, reflectors, or prisms for directing the emitted light. Some of the illumination sources **42***a*, **42***b* may comprises light sources of a single color. Alternatively, the illumination sources **42***a*, **42***b* may comprise light sources of more than one color, which may be operated to produce a greater number of perceived colors. For example, one or both of the illumination sources **42***a*, **42***b* may comprises groups of red light emitting LEDs, blue light emitting LEDS and/or green light emitting LEDs, positioned closely together and operated to produce over 16 million perceived color combinations. Also for example, one or both of the illumination sources **42***a*, **42***b* may comprise color filters for transmitting light of various colors, for example three color filters in order to produce over 16 million perceived color combinations.

With continuing reference to FIGS. **2** and **3**, the traffic visual indicator device **24** also comprises a wireless communications subsystem **48**. The wireless communications subsystem **48** may comprise an antenna **48***a* and a receiver and/or transmitter or transceiver **48***b* (FIGS. **9**A-**9**D). The antenna **48***a* may employ a variety of designs and/or positions to maximize signal reception and/or transmission. The antenna **48***a* may, for example, extend across a top **38** of the traffic visual indicator device **24**. For example, the antenna **48***a* may be centered in the traffic visual indicator device **24**, and may be formed as a plane on a layer in a printed circuit board. The antenna **48***a* may extend perpendicularly to the surface **14** of the road **12**. The antenna **48***a* may advantageously bend at an approximately right angle, around one or more edges of the traffic visual indicator device **24**. The antenna **48***a* may be tuned to 0.25 W.

The traffic visual indicator device **24** further comprises a power producing source **50**. For example, as illustrated in FIG. **2**, the power producing source **50** may comprise one or more photovoltaic cells **50***a* for converting insolation into electrical current. The photovoltaic cells **50***a* may be protected by the clear top **38** of the housing **34**. Alternatively or additionally, as illustrated in FIG. **3**, the power producing source **50** may comprise one or more pressure transducers **50***b*, for example piezo-electric transducers, for converting pressure or pressure changes into electrical current. Alternatively or additionally, as illustrated in FIGS. **2** and **3**, the antenna **48***a*, or some other antenna may capture electromagnetic radiation, for example in the form of RF transmissions, and appropriate circuitry can converter the electromagnetic radiation into electrical current. Such an approach is presently used in passive radio frequency identification (RFID) technology.

As illustrated in FIG. **2**, the traffic visual indicator device **24** may further comprises one or more ambient transducers for detecting or sensing conditions of the ambient environment. For example, traffic visual indicator device **24** may include one or more acoustical transducers **52***a*, which may be capable of detecting and producing sound. As illustrated in FIG. **4**, the acoustical transducer **52***a* may be positioned on a third face **40***c* of the housing, for example, where the first and second faces **40***a*, **40***b* are encumbered by the first and second sets of illuminations sources **42***a*, **42***b* such as in the embodiment of FIG. **3**. Also as illustrated in FIG. **4**, the traffic visual indicator device **24** may include one or more through-holes **54**, discussed in more detail below with reference to FIG. **5**.

The traffic visual indicator device **24** further comprises circuitry **56** (FIGS. **9**A-**9**D) which may include one or printed circuit boards including one or more processors (e.g., microprocessor, digital signal processor, application specific integrated circuit or the like) and or discrete electrical components (e.g., inductors, transformers, antennas, energy storage devices such as rechargeable and non-rechargeable batteries and/or ultracapacitors). Such circuitry is discussed in detail below with reference to FIGS. **9**A-**9**D.

FIG. **5** shows the traffic visual indicator device **24** in conjunction with an anchoring mechanism **58***a* according to one illustrated embodiment.

The anchoring mechanism **58***a* may include a base plate **60** and an elongated stem **62** extending from the base plate **60**. The base plate may be sunk in the road **12** to provide a smaller above surface profile, improving durability, an may have a lip formed around a perimeter thereof. The stem **62** may provide greater support and may improve the ability to adhere to the road **12**. The stem **62** may, or may not, include one or more flanges or flutes **64** for improving device retention and limiting twisting or turning once mounted. The flanges or flutes **64** may run vertically down the length of the stem **62** and may be deep enough to act as a flange that improves the lateral support of the traffic visual indicator device **24** in adhering to the road **12**.

A fastener **66** may be received through a through-hole **54** (FIG. **4**) extending through a face **40** and/or top **38** of the housing **34** to secure the top **38** and/or base **36** to the base plate **60** of the anchoring mechanism **58***a*. The fastener **66** may, for example, be a security screw, expansion bolt, or other tamper-resistant mechanism.

Additionally, a pair of rails (not shown) may be coupled to the base plate **60** and/or the traffic visual indicator device **24** to reduce the likelihood of damage to the traffic visual indicator device **24** from excessive forces, for example those applied by snow plows. The rails may extend from the traffic visual indicator device **24** toward the approaching traffic, and form a decreasing angle of inflection leading up to the traffic visual indicator device **24** to guide the blade of the plow over the traffic visual indicator device **24**. The rails may be coupled to the traffic visual indicator device **24** via two or more holes and fasteners, and may be fixed to the road **12** at distal ends of the rails.

FIG. **5** also shows one or more optical guides **68** that may provide an angled tunnel that seals to the respective face **40***a*, **40***b*, and which may focus the emitted light.

FIG. **6** shows another environment **10***b* where the traffic information system **22** comprises traffic visual indicator devices **24***a*-**24***f*, **24***j*-**24***o*, extending completely across the road **12** on both sides of the crosswalk **20**.

The embodiment of FIG. **6** also shows a photovoltaic array **70** coupled to provide power to the activation devices **26***a*, **26***b*. This is particular suitable for rural locations, where the utility grid may lie at a great distance from the particular location. The photovoltaic array **70** may be conveniently mounted on the pole **30***a*. While FIG. **6** illustrates a photovoltaic array **70**, the activation devices **26***a*, **26***b* may employ other sources of power, such as a manually operated generator or batteries, or a utility grid where available.

FIG. **7** shows further aspects of the traffic visual indicator device **24**.

As noted above, the traffic visual indicator device **24** may include one or more sets of illumination sources **42***a*, **42***b* carried by the housing **34** of the traffic visual indicator device **24**. There may also be one or more sets of illumination sources **42***a*, **42***b* and/or acoustical transducers on each face **40** of the traffic visual indicator device **24**. Each of the illumination sources **42***a*, **42***b* may include one or more LEDs **46** (FIG. **2**). The LEDs **46** may be of a single color, or a variety of colors, for example a sequence of red-blue-green to form over 16.7 million colors. However, each LED **46** should operate at a maximized wavelength for the color of light sought by function of the traffic visual indicator device **24**. In maximizing the wavelength at the LED level, rather than by using an additional lenses, up to an 80% improvement in optical output and efficiency may be maintained.

As further illustrated in FIG. **7**, the photovoltaic array **50***a* should cover the maximum area possible while maintaining the other functions of the traffic visual indicator device **24**, in order to ensure the greatest levels of insolation. Alternative embodiments may not require a photovoltaic cell, in which case this feature is not needed.

The traffic visual indicator device **24** may include one or more mounting bracket well **72** aligned with through-holes **54** for adhering the base **36** of the traffic visual indicator device **24** to the base plate **60** of the anchoring mechanism **58***a* via one or more fasteners **66** (FIG. **5**). The mounting bracket well **72** may be offset of center to improve the lateral support. By creating an internally displaced cavity, each mounting bracket wells **72** may offer a flat plane for a mounting assembly, such as a security screw. Additionally, the cavity formed by the mounting bracket wells **72** preserves the head of the mounting assembly as well as its structural integrity, by keeping it protected from the wear from traffic, such as vehicular tires.

The use of an anchoring mechanism **58***a* advantageously provides a removable base **36**, via a detachable assembly such as a clamp system or screw off base. The anchoring mechanism **58***a* may also include a watertight seal, such as a resilient washer assembly in between the inside of the removable piece and the rest of the stem. By having a removable design along the base **36** of the stem **62**, permits easy replacement of a power storage device V_B (discussed below) such as a rechargeable or non-rechargeable battery.

Further as illustrated in FIG. **7**, the antenna **48***a* may be placed along the top **38** of the traffic visual indicator device **24**, yet below the clear protective housing that protects the power producing source **50** (e.g., photovoltaic cells **50***a*), to ensure signal optimization. The antenna **48***a* may be positioned either in the middle of top **39** of the traffic visual indicator device **24**, or along the perimeter in between the edge of the traffic visual indicator device **24** and the power producing source **50**, in order to provide maximum exposure of the antenna **48***a* to the activation devices **26***a*, **26***b*.

FIG. **7** also illustrates the low profile of the traffic visual indicator device **24**. The angular design of the traffic visual indicator device **24** minimizes surface obstruction allowing vehicles easily pass, while retaining maximum functionality, such as visibility of illuminations sources **42***a*, **42***b* and/or audibility of acoustical transducer **52***a*.

The traffic visual indicator device **24** may include an optical assembly channel **74** that goes inside the housing **34** The optical assembly channel **74** may include a reflective internal coating and be light-tight on the internal side, sealing securely to the optic source, such as a high output LED. A plastic bushing may be used to improve the light-tight adhering of the optic source to the optical assembly channel **74**. By preventing light leaking out the backside of the optical assembly channel **74** and by making the internal coating reflective, improvements on the optical output will be found. Additionally, the channel **74** may be angled such as a cone to disperse the light in the most appropriate and effective manner, with a rounding of the body-side of the channel **74** to refract light toward the opposite and desired end.

FIG. **8** shows the traffic visual indicator device **24** in conjunction with an anchoring mechanism **58***b* according to another illustrated embodiment.

As illustrated in FIG. **8**, the base plate **60** may have the same dimensions as the base of the traffic visual indicator device **24**, allowing a flush finish between the base **36** and the base plate **60**, that will minimize the potential of pinches or cuts when handling. The base plate **60** may be smooth and well finished, and may be flush with surface, mounted on top of surface, or mounted slightly beneath the surface. The traffic visual indicator device **24** in generally, and the base **36** and base plate **60** in particular, may be of any geometric shape, whether as depicted (i.e., square), round, rectangular, etc. The traffic visual indicator device **24** should also be thin enough to minimize the overall height and potential obstruction to surface-level traffic, yet thick enough to provide ample strength and functionality, such as for threading of mounting screws to traffic visual indicator device **24**.

One or more cuts and/or grooves **76** may be formed in a top surface **78** of the base plate **60**. Such may increase the surface area, providing space for a seal to be used between the base **36** of the traffic visual indicator device **24** and the top surface **78** of the base plate **60**. This seal may be waterproof and/or an adhering material. Thus, the PCB, and all components including the power storage device V_B may be sealed, for example using a silicone gel, to provide structural protection and to render the traffic visual indicator device **24** water or moisture resistant.

The base plate **60** may include one or more tapping screw holes **80**. The tapping screw holes **80** may be used for additional in-road fasteners, such as expander bolts or screws that help fasten the base plate to the road **12** (FIGS. **1** and **6**). The tapping screw holes **80** may also be used to provide additional support and preservation of lateral orientation of base plate to road **12**.

The base plate may also include one or more mounting holes **82** to facilitate adhering the traffic visual indicator device **24** to the base plate **60**. If the base plate **60** includes more than one mounting holes **82**, the mounting holes **82** may be offset from center to improve the lateral integrity of the hold. Additionally, the mounting holes **82** may be threaded, allowing for use of standard screws. Special security screws may also be used to minimize unauthorized removal of traffic visual indicator device **24** from the anchoring mechanism **58***b*.

As best illustrated in FIG. **8**, base plate **60** may have an aperture **84**, formed as an approximately cylindrical hollow fluted member, extending through the base plate **60** for receiving a proximate portion of the stem **62**. The seal between the aperture **84** and the stem **62** may be watertight, to prevent saturation of debris or liquid that might hinder performance or hinder maintenance of the traffic visual indicator devices **24**.

The stem **62** should be large enough to fit the stem yet small enough to minimize the required diameter and length of hole that must be bored into surface. The stem should be durable enough to withstand pressures placed on the traffic visual indicator devices **24** while providing enough depth or length to provide ample room for a possible extension of the stem.

The anchoring mechanism **58***b* may include a foot **86** that acts as a support to keep the base plate **60** from turning, providing additional lateral support to anchoring mechanism **58***b*. The length of the foot **86** may be customized to fit the exact diameter of a boring device in order to minimize the size of the hole required to receive the anchoring mechanism **58***b*. The foot **86** should have a width that is smaller than its length, so that an adhering material that helps keep anchoring mechanism **58***b* mounted to the road **12** may flow past the foot **86** to reside around the flutes of the stem **62**, securely and firmly anchoring the anchoring mechanism **58***b* to the road **12** The ends **88** of the foot **86** may be rounded to facilitate ease of insertion by a standard boring device during installation, such as via a coring tool or drill. The length of the foot **86** and hence its subsequent effectiveness may be maximized by rounding the ends **88** to the same or smaller angular arc as boring device used to create the hole in the road **12** that receives for the anchoring mechanism **58***b*.

The anchoring mechanism **58***b* may further include a flange **90** extending between the stem **62** and the foot **86**. The flange **90** may be any of a variety of shapes, including square or triangular, and may attach to the bottom of base plate **60** or rounded foot **86** at the bottom of the anchoring mechanism **58***b* (as shown herein). One or more flanges **90** may be used to provide additional lateral support to the anchoring mechanism **58***b* and traffic visual indicator devices **24**.

FIG. **9**A-**9**D are an electrical schematic of the traffic visual indicator devices **24** including circuitry **56** according to one illustrated embodiment.

The traffic visual indicator devices **24** may include one or more power storage devices such as a battery V_B. along with a smoothing capacitor C**1** electrically coupled thereacross. The traffic visual indicator devices **24** may include a power regulation circuit **91** comprising a charge/discharge controller U**1** along with an inductor L**1**, capacitor C**2**, and diode D**1**. The power regulation circuit **91** may be operable to condition power, for example increasing or decreasing voltage, and may be operable to limit the prevent the flow of power from the battery V_B to the power producing source **50** when the voltage of the battery V_B is higher than the voltage of the power producing source **50**. The power regulation circuit **91** may be designed or selected to maximize the particular conversion, for example, the conversion of solar power to electrical current for supply to a load and/or power storage device V_B. In one embodiment, the traffic visual indicator devices **24** may employ more than one photovoltaic cell and more than one power storage device V_B in order to maximize the conversion efficiency. In one embodiment, the photovoltaic cells may produce approximate 2V, with a drop of 0.3V across the diode, and 1.35V for charging a single 1.2V "C-type" battery, leaving approximately 0.35V for operating the LEDs **46**, or shunted and/or dissipated as heat. The charge level of the power storage device V_B may checked periodically, for example, every 100 clock cycles or every 30 minutes. While, the traffic visual indicator devices **24** may employ shunting of power where the power storage device V_B is fully charged, the activation devices **26** will typically not employ shunting but will rather dissipate the excess power in the form of heat at the photovoltaic array **70** (FIG. **6**).

The traffic visual indicator devices **24** may include a processor U**2** for controlling operation of the various elements and executing functions. An interface I provides a programming interface or header for reprogramming the controller U**2**. The traffic visual indicator devices **24** may also include a drive controller U**3** for controlling operation of the various light sources such as LEDs **46** to produce the desired output. With respect to wireless communications, a single communications controller chip may implement both transmitter and receiver, and thus be denominated a transceiver U**4**. Inductors L**2**, L**3** and capacitors C**10**, C**11**, C**11** may be coupled across the antenna **48***a* for impedance matching. The transceiver U**4** may operate in three modes, including 1) transmit, 2) listen, and 3) sleep to maximize power efficiency. The traffic visual indicator devices **24** may be in the sleep mode while flashing the LEDs **46** and during most of its normal operation. The traffic visual indicator devices **24** may transmit data based on a time of day, month or device memory limits, for example before on-board memory fills up.

The circuitry **56** may be formed and/or carried on a multilayer printed circuit board (PCB). The PCB may adjust a distance between the power producing source **50** and other components, while also supporting an antenna **48***a* one a side of the PCB opposite the other components. The PCB may include multiple power regulators to handle high output requirements of the LEDs **46**. Power may be cycled to provide for deep charge to charging of the power storage device V_B, to increase the life of the power storage device V_B, and may, for example, be based on a time of year and/or an average amount of power absorption, such as a 30 day average.

As illustrated in FIG. **31**, the photovoltaic cells may be arranged in two or more groups of two or more photovoltaic cells **50***a*(**1**), **50***a*(**2**), **50***a*(**3**). Each group of photovoltaic cells may be associated with a respective diode D(**1**), D(**2**), D(**3**). While such will incur a loss of efficiency during normal operation, this approach allows a diode, e.g., D(**2**) associated with a malfunctioning group of photovoltaic arrays **50***a*(**2**) to be turned "OFF" to prevent the leakage of current through the "valve" that might be otherwise be dissipated by the photovoltaic cells **50***a*(**2**).

The output of the LEDs **46** may be increased when the power storage device V_B is fully or nearly fully charged, in order to dissipate heat and/or increase brightness. The controller and/or processors may selected based on a power profile of the traffic visual indicator device **24**. Thus, the controller and/or processor selection may be in order to optimize various aspects of the traffic information system **22**, based on factors such minimizing voltage in order to reduce cost and inefficiencies that result through the waste of signal voltage, yet to provide sufficient voltage to realize the desired functionality. An external crystal may be used to improve the timing of individual LEDs **46** should an internal oscillator X_1 (FIG. **9**A-**9**D) does not provide sufficient accuracy.

Interaction between the various subsystems and components of the traffic visual indicator device **24** is best illustrated in FIG. **11**.

Thus, as specifically discussed above, One or more of the traffic visual indicator devices **24** include one or more illumination subsystems, which may include one or more optical components, for example LEDs such as a multitude of organic LEDs, that may face one or more directions. The optical components may be capable of projecting one or more colors, including the forming of a high-density graphical display that may be used for applications from text messaging, graphics and images, or video.

One or more of the traffic visual indicator devices **24** may also include one or more acoustical transducers, such as a speaker and/or microphone, for detecting and/or producing sound. Each traffic visual indicator device **24** may dynamically adjust a volume of an audio output based at least in part on a volume of ambient noise.

One or more of the traffic visual indicator devices **24** may be shaped in a variety of geometric designs. In some applications it should be small enough to be portable and carried or mounted individually, with a sufficiently low clearance and angular design so as to allow vehicles to pass over the traffic visual indicator device **24** with minimal need for caution. The base of each traffic visual indicator device **24** or anchoring mechanism may also include a stem or sub-surface chamber for additional support and adhering ability.

Protective hardware may be used to lock one or more of the traffic visual indicator devices **24** into a secure hold with the road **12**. This may include the use of security or tamper proof hardware such as screws and/or expander bolts to facilitate both temporary and permanent attachment to the road **12**. The base plate of the anchoring mechanism may be made out of one or more materials including metal, metal composite, synthetic, or organic based materials and may be flush mounted, surface mounted, or imbedded into the road **12**. It base plate may also contain a small locking mechanism, for example, a foot to prevent the anchoring mechanism from being easily pulled out of the road **12**.

Specialized bonding or sealing materials may be used to adhere the traffic visual indicator device **24** to the base plate of its respective anchoring mechanism and/or the road **12**, including adhering the base plate, if used, to the road **12**. This may be in addition to or in replacement of any mounting hardware.

One or more of the traffic visual indicator devices **24** may also include a reflective mechanism to highlight its location even when not being actively used for providing visual communications. This reflective mechanism may be a standard plastic reflector adhered to the body of the traffic visual indicator device **24**, may face one or more directions, and may be one or more colors.

One or more of the traffic visual indicator devices **24** may also include an assembly that absorbs or receives energy from its environment. This may be through one or more photovoltaic cells, a wireless radiation receiver that captures energy, pressure transducer activated by passing traffic, as well as one or more energy inverters, circuit breakers, electric meters, and other related assembly components.

One or more of the traffic visual indicator devices **24** may include processing functionality, such as one or more printed circuit boards (PCBs) and may contain the following assembly components: resistors, capacitors, inductors, crystals, transistors, flash memory, RAM, a regulator, processor, RF transceiver circuitry, micro controller circuitry, and a power switching converter circuit.

One or more of the traffic visual indicator devices **24** include a wireless communications subsystem that may contain one or more antennas **48***a*, transmitters, receivers, transceivers U4 and signal modulation and/or control devices.

One or more of the traffic visual indicator devices **24** may include one or more energy storage devices V_B. The energy storage devices V_B may include one or more rechargeable batteries, one or more non-rechargeable batteries, and/or one or more super- or ultra-capacitors.

One or more of the traffic visual indicator devices **24** may include one or more ambient sensors or transducers that allow it to interact with its ambient environment. This may include electromagnetic, precipitation-based, seismic, inductive, acoustical, or optical sensors that allow the traffic visual indicator device **24** to obtain information for data capture and/or processing. For example, one or more of the traffic visual indicator devices **24** may include one or more monitoring devices such as a photo imaging device or video capture device. This may also include one or more data or proximity interaction devices, such as an external microprocessor chip device or smart card. Communications apparatus may be purely for the collection and transmission of data that each traffic visual indicator device **24** collects and/or distributes to its environment. Additionally, one or more of the traffic visual indicator devices **24** may interact with a separate environmental sensor, including electromagnetic, precipitation-based, seismic, inductive, audio, or optical sensors, including but not limited to loop detectors, time-of-day configuration, radar, etc.

The traffic information system **22** may include a option rich software interface that allows each traffic visual indicator device **24** to be updated based upon a large variety of options remotely and before or after installation. This includes the interface not only for updating but also for receiving data and system diagnostics. It may be loaded onto a variety of devices, including laptops, PDAs, etc and may connect with the wireless software transceiver (ST) via Ethernet, serial, USB, or other methodology.

A wirelessly controlled, self powered, intelligent traffic visual indicator devices **24** is described that intercepts commands and receives information from its environment **10**, processes the information, and writes, transmits, or stores it for current or future use, which may be used in numerous applications and encompassing numerous embodiments including those for advanced warning, notification, and identification of obstacles, situations, and states of communication need its deemed audience including for people and organizations such as government, police, hospital, ambulance, construction, service and other public and private entities. Each traffic visual indicator devices **24** may provide direct information, such as the flash of a yellow light to warn of a crosswalk ahead or text messaging to warn of unsafe road or situational conditions, or symbolic information such that it notifies said deemed audience to act or behave in a particular fashion, such as to warn citizens of a regional disaster, requiring they abstain from driving or seek additional information before proceeding in a normal daily routine.

Each of the traffic visual indicator devices **24** takes sensory information from its environment or specific instruction from persons monitoring said device, processes it, and delivers a form of output. The output may be in one or more electromagnetic ranges including those in the (1) optical spectrum including lighting, pictures, and video, (2) audio including sound, voice, and other intelligible or non-intelligible signaling, and (3) data linking to one or more recording or interactive devices such as a base station, transceiver, processing unit, or network accessible device.

Based upon dynamic environmental information, in at least one embodiment the traffic visual indicator devices **24** receives one or more sensory inputs, processes them, and responds with a resulting action. Information includes that of electromagnetic stimuli including magnetic polarity, radio, microwave, infrared, visible light, ultraviolet, X-rays, gamma rays, and/or cosmic rays.

One advantage may be the ability to complete one or more modes of operation within the tight confines of a self-powered, wirelessly controlled, open environment. Such an approach may resolve a variety of power issues, while working within the confines of both national and international regulations on wireless signaling.

The described embodiments provide advanced and supplemental notification to and communication with motorists, pedestrians, and bicyclists. By placing one or more traffic visual indicator devices **24** along one or more surfaces including bike paths, sidewalks, walking trails, roadways, and commercial environments, a variety of communications may be performed. Each may perform as a visual, audio, or combinations of audio and electromagnetic communication. Rather than dealing with geographic and environmental requirements relating to electrical power availability and communications wiring, each traffic visual indicator device **24** installs easily, with one or more tools such as a core-boring tool. This makes them extremely flexible, negating typical requirements of bringing power to each implementation. Implementers of invention benefit from this attribute by gaining considerable flexibility and freedom for deploying said invention. Once a suitable location is found, one or more traffic visual indicator devices **24** typically get installed on a roadway. This includes using the traffic visual indicator devices **24** either perpendicular or parallel to the path of traffic. Furthermore, traffic visual indicator devices **24** may be used in other presentation formats that maximize the ability of the traffic visual indicator devices **24** to be noticed and underlying purpose for the traffic visual indicator device **24** implementation.

As illustrated in FIGS. **1** and **6**, according to one embodiment, the traffic visual indicator devices **24** may be installed along the path of a pedestrian crosswalk. Each of the traffic visual indicator devices **24** directs optical emissions toward oncoming traffic with optional optical and audio notification for crossing pedestrians, allowing each to both see and/or hear that optical communication is being performed for approaching traffic. As a pedestrian or cyclist approaches said traffic visual indicator device **24** deployment, one or more methods of activation may be used, including a manual push button, motion sensor, time of day programming, or a dynamic traffic flow monitoring tool. Prior to entering the path of traffic, each of the traffic visual indicator devices **24** begins to flash toward approaching traffic with flash warning and audio/or messaging to the pedestrian or bicyclist, as they proceed into the path of traffic, through the crosswalk. Flashing and audio messaging may be fully configured in advance based upon a variety of constraints by traffic engineer or city planner through use of a full-featured software configuration tool (ST) **92** (FIG. **10**). Toward the end of each crossing cycle, the flash frequency of each of the traffic visual indicator devices **24** may be increased, along with audio countdown timing announcements via the acoustical transducer **52***a* (FIG. **2**), to better communicate the conclusion of each crossing cycle to the pedestrian or bicyclist crossing the path of traffic.

Traffic visual indicator devices **24** do not require an additional, outside power producing source. This ability to provide self-power enhances the flexibility of each system **22**, as it allows the traffic visual indicator devices **24** to be placed and used outside existing areas with power. Furthermore, each of the traffic visual indicator devices **24** installs quickly and easily, without trenching or saw-cutting. Thus, the methods and apparatus for maximizing efficiency of each of the traffic visual indicator devices **24** is considered novel.

According to one embodiment, a power producing source **50** absorbs energy from a radiation source such as the sun or another radiation source from one or more self-powering assemblies such as photovoltaic cells **50***a*. This can be used in conjunction with an energy storage device such as a rechargeable battery V_B (FIGS. **9**A-**9**D). Additionally, for locations of little or no solar exposure, a specialized long lasting energy storage device such as non-rechargeable battery may be used.

The traffic visual indicator devices **24** may includes a one-way energy valve diode that controls the energy storage device V_B leaking to the power producing source **50** during times when there is little or no solar exposure or radiation collection capability and manages the power cross-over between one or more of the rechargeable and/or non-rechargeable power storage devices. This energy valve diode may be configured with one or more sensor tiers, monitoring the flow of energy between the self-powering mechanism (i.e., power producing source **50**) and the power storage device. A voltage comparator is used to detect the direction of current flow through the switch connecting the power storage device to the self-powering assembly. If the self-powering assembly voltage is greater than the voltage of the power storage device, the switch is more forward biased allowing the charging current to flow into the power storage device. If there is no sunlight/radiation and the power absorption mechanism has little or no output then the voltage comparator senses this condition and turns the switch in a reverse or negative bias in order to prevent the current flow from the power storage device back to the power absorption mechanism. This energy preservation technique also protects the longevity of the power absorption mechanism.

The traffic visual indicator devices **24** may also include a unique directional current sensor that reduces the effective loss in the diode by as much as 90% from conventional means. This operates in a similar fashion to that of the energy valve diode. This directional current sensor may also be configured with one or more sensor tiers, monitoring the flow of current between the self-powering mechanism and the power storage device. A voltage comparator is used to detect the direction of current flow through the switch connecting the self-powering mechanism to the power storage device. If the self-powering mechanism voltage is greater than the power storage device, the switch allows the charging current to flow into the power storage device. If there is no sunlight and the power absorption mechanism has little or no output then the voltage comparator senses this condition and reverses the switch in order to prevent the current flow from the power storage device back to the self-powering mechanism.

The signaling method employed in this system may advantageously use a distributed and alternating methodology such as frequency shift keying (FSK). In order to best identify the congestion level at a particular frequency, a novel and unique frequency band test is performed with a monitoring sensor that changes the frequency to a subsequent shift when congested. Additionally, to ensure FCC regulations for power output, a distributed and alternating frequency methodology allows a higher output, which improves reliability and accuracy of wireless signal and data transmission.

In order to maximize operational efficiency in the tight power constraints met by use of certain self-powering mechanisms, like solar power, several threshold controls monitor the recharging of the power storage device from the self-powering mechanism. As described in detail below, this includes one or modes such as Passive, Active, Service, and Sleep. Each threshold level maximizes power efficiency for that state. As the receiver is the largest usurper of power, under normal conditions using traditional battery control methods, the battery would be depleted very quickly. Multiple voltage comparators are set for different thresholds and their second input commonly tied to the power storage voltage. Their outputs are logic levels and are fed to the microcontroller integrated circuit. The microcontroller integrated circuit reads these outputs and based on the output logic level, decides on the appropriate operating mode. By having different modes, more power intensive cycles may be limited to a particular mode. This further improves efficiency of the traffic visual indicator devices **24**.

As illustrated in FIG. **10**, according to an embodiment suitable for a crosswalk application, the traffic visual indicator devices **24** waits for a wakeup call from the activation device **26**. By using communication modulation of the wireless signal sent from the activation device **26** to each traffic visual indicator device **24**, additional power savings is realized. This is achieved by mass sum signaling, whereby each traffic visual indicator device **24** need only hear less than one percent of the total broadcast of the activation device **26**, in order to pass from a standby mode to an active mode. Additional power savings stem from a system of switches that reduce the consumption of each microcontroller based upon the function. This novel development saves over 80% in energy efficiency at 1.2 volts from standard processes.

In order to improve the reliability of the wireless link between the activation devices **26** and each traffic visual indicator device **24**, the system **22** may employ a process called packet minimization. Packet minimization reduces the protocol bit length for each critical active packet while reverting to standard data packet lengths on non-critical commands. This improves flexibility, efficiency, and overall value for deploying service commands and structural updates and broadcasts. This greatly enhances the functional reliability of the wireless transmissions and improves the ability of each traffic visual indicator device **24** to hear and follow remote orders and instruction.

In order to obtain the greatest amount of information from each traffic visual indicator device **24**, each has the ability to be individually addressed and identified. This is useful for service updates relating to individual device usage statistics, information for diagnostic analysis, environmental identification, and device specific communication. A process of writing this unique address or identifier on each PCB is performed prior to configuring each traffic visual indicator devices **24** or system **22** for deployment, and may be written into the imbedded code on each traffic visual indicator device **24**. Additionally, each traffic visual indicator device **24** monitors the current power storage levels. In instances with a rechargeable device, at times when solar absorption has maximized the rechargeable level of the power storage device V_B, the traffic visual indicator device **24** uses the solar power to send data and status updates to the activation device **26** for storage and ultimate downloading to the site administrator.

Signaling from each activation device **26** to traffic visual indicator devices **24** occurs on two or more channels. This channel differentiation provides greater accuracy, improves distance, and heightens quality of the wireless communications signal. Because there is no physical communications link between the activation devices **26** on each side of the crosswalk in some embodiments, the first crosswalk activation device utilizes "channel **1**", communicating to each additional activation device **26**, which broadcasts on "channel **2**", or a subsequent channel to each traffic visual indicator device **24**. Each activation device **26** is configured to always listen for a status command from a subsequent activation device **26**. Upon receiving this command, the activation device **26** switches to a subsequent channel, broadcasting to the other traffic visual indicator device(s) **24**. This increases potential distance limitations seen by signal restrictions placed by the FCC that limit power and signal strength. It also minimizes interference while eliminating normal communication confusion from traffic visual indicator devices **24** when receiving commands from multiple activation devices **26**. Each traffic visual indicator device **24** may receive on any channel, thereby allowing greater flexibility of use for each signal activation mechanism. This feature also allows traffic visual indicator devices **24** to perform multiple, unrelated tasks, assisting in additional preferred embodiments, such as communication repeaters.

A method for regulating traffic visual indicator device communication consistency may also be used. With standard wireless communication, interference and signal obstruction become problematic issues. When one or more traffic visual indicator devices **24** miss a command to activate, under normal circumstances they begin to flash out of sequence over time. By regulating the communication consistency, this flash cycle is no longer an issue. Each activation device **26** broadcasts the activation prompt for more than one signal cycle. However, a vehicle or third-party interference may inhibit the traffic visual indicator device **24** from receiving the activation commands. With communications consistency, even after other traffic visual indicator devices **24** activate their communication cycle, the previously inhibited traffic visual indicator device **24** jumps in with them at the proper communication rhythm, flashing or communicating in unison with the other traffic visual indicator devices **24** while also ending at the proper time. Instead of getting out of turn or continuing for a time period longer than the others, each traffic visual indicator device **24** knows how many cycles it missed and subtracts them from the total cycle duration, so all traffic visual indicator devices **24** conclude their sequence at the same time.

The present approach may also include a method for communicating staggered requests of the same scenario. For example, a unit A would flash three times with a 50% duty cycle and 1 hertz flash rate while an unit B might also flash three times with a 50% duty cycle and 1 hertz flash rate. However, with "staggered output signaling," a novel approach may allow unit A to operate for a series while unit B waits. When unit A completes its (three-flash) sequence, unit B flashes (three times), passing back and forth like this until the end of the flash cycle. The methodology for doing this with multiple staggered outputs is considered novel. The time delay is programmed into each microcontroller. The A delay equals to zero and B delay equals to the time required to complete the number of flashes (service command) at the flashing frequency (another service command). The microcontroller calculates the time delay form these two commands and adds it to the flashing sequence when activated.

Operation of the traffic visual indicator devices **24** may include a method of using an electromagnetic sensor to filter out extraneous signal noise, increasing reliability and functional integrity of each traffic visual indicator device **24**. This unappreciated benefit improves reception of the in-band frequency resulting in greater signal reliability and communications integrity. By utilizing this electromagnetic sensor, each traffic visual indicator device **24** effectively reduces the signal strength of non-known frequencies and wavelengths, so that it may focus on those FSK frequencies it requires for operation.

The ST may be configured to control any individual sensor and/or LED from remote means. By the unique graphical depiction of the traffic visual indicator device **24** on the ST, a system manager may select one or more functions for each traffic visual indicator device **24**. This unique functionality allows greater control and functionality while also allowing each traffic information system **22** to operate in a power or output maximized setting. This sensor management allows for output, such as LED lighting, to be changed or modified without the need of replacing a traffic visual indicator device **24**. It is also a novel approach to allowing system administrators the flexibility of determining the most desired configuration based upon output needs coupled with power absorption assembly.

The present approach may also include one or more preventive maintenance tools. Wireless radio circuits use a quartz crystal for their frequency reference. However, over time and due to temperature and phase noise, both long and short-term frequency drift occurs. To minimize this natural phenomenon, the activation device **26** records the shift integrity during one of the diagnostic modes and updates the ST of frequency drift levels. This novel proactive management approach allows the traffic information system **22** manager to replace the traffic visual indicator device **24**, modify the crystal, or correct the frequency in the wireless radio circuit.

The system **22** may use spread spectrum signaling, such as frequency hopping, to communicate more effectively and efficiently. This development results in one thousand times the normal output compared to what is normally realized in FCC regulations and is a unique development for this application. This technical effort greatly enhances the efficiency and integrity of the communications signaling. This may be accomplished in one or more wireless bands, including the 2.4 GHz ISM band. Regardless of the wireless band, invention uses one or more types of wireless transceivers for its operation and maintenance. With spread spectrum signaling, the transmitter power may be increased as compared to a standard fixed frequency operation. This increases the wireless communication range 32 times to that of fixed frequency signaling.

LED control is used to further maximize energy and life of each traffic visual indicator device **24**. A method was developed to control the brightness of each LED based upon the output of each self-powering mechanism (i.e., power producing source **50**) such as a photovoltaic assembly. The brightness of each LED is also varied based on the energy storage device such as the battery charge level. This maximizes the charge and subsequent life of each rechargeable battery while also protecting it from overcharging and failure. A novel approached is developed for increasing or decreasing actual LED output based upon dynamic environmental factors. This system **22** can also be manually overridden, if so desired by system deployment manager in the ST. The microcontroller has an integrated analog to digital converter. The battery voltage is fed to one of the analog to digital converter inputs. The microcontroller samples the power storage voltage over a predetermined time period and integrates its value. The power storage charge level can be extracted from this value. If the power storage device's charge level comes close to 100% (or the desired level tier, as defined by the system administrator in the ST) the sensory output level of each traffic visual indicator device **24** increases. The increased current drains the power storage device faster preventing overcharging. The energy is not wasted but used towards the useful task of increasing the communications intensity of the traffic visual indicator device **24**. If the power storage charge comes close to 0% the microcontroller delays or suspends sensory output and other power hungry tasks until the self-powering mechanism builds up a predefined charge in the power storage device.

As defined earlier in this document, the traffic visual indicator device **24** gets mounted on or embedded into a surface such as a roadway, to perform one or more communication and sensory functions. In this preferred embodiment, it provides optical and/or acoustic notification to approaching motorists of an impending pedestrian or cyclist presence. The traffic visual indicator device **24** may achieve this optical notification through one or more light emitting diodes (LED) and an audio assembly. The traffic visual indicator device **24** also contains a wireless controller printed circuit board (PCB), a self powering mechanism such as photovoltaic cells, one or more energy storage devices which may include a primary (non-rechargeable) battery and a secondary (rechargeable) battery, and housing which may be hermetically sealed. The wireless controller PCB facilitates the wireless communication to the activation devices **26** and ST units **92**, controls the communication sequence of the LEDs, dictates the audio messaging to each traffic visual indicator device **24**, monitors and regulates the charging current from the self powering mechanism to the energy storage device, and stores the various operating variables into its integrated memory for future retrieval. The wireless controller PCB hosts the frequency transceiver, which may be radio frequency, the integrated circuit, the microcontroller integrated circuit, the integrated antenna, the self-powering mechanism, one or more various sensors (e.g., camera, light sensor, temperature sensor, humidity sensor, etc.) and the power conditioning and regulation circuitry.

Depending on the operating conditions, the traffic visual indicator device **24** may enter one or more operating modes such as: Passive, Active, Service, and Sleep. The ST **92** may also control the traffic visual indicator device **24** to enter any of the aforementioned modes for testing and servicing purposes.

Mode One—a default mode that initiates upon initial activation of the traffic visual indicator device **24**. The microcontroller integrated circuit operates in a reduced power mode and the radio integrated circuit cycles between the active and shutdown states with a low duty cycle such as 2% active and 98% shutdown. This allows the traffic visual indicator device **24** to conserve power while retaining a full signaling awareness for operation commands.

Mode Two—a mode such as this can allow the traffic visual indicator device **24** to enter active mode only upon reception of an activation device **26** wakeup or ST **92** wakeup command. In active mode the traffic visual indicator device **24** may keep the radio integrated circuit also in the active mode continuously in order to receive additional command structure signaling or requests.

Mode Three—a mode such as this can be initiated by the ST **92** or automatically upon sensing a power tier where the voltage level in the power storage device enters a low threshold state. The purpose of this mode is to prevent further discharging of the power storage device(s) due to continued operation of sensory outputs such as LEDs and an audio assembly. The traffic visual indicator device **24** in this mode does not respond to operation commands but only service commands. If the service mode was initiated due to the crossing of the appropriate voltage threshold the unit can return to standby mode once the normal power storage device threshold has been exceeded, or go into sleep mode if the power storage device's voltage falls below critically low threshold. If the service mode was initiated by service request command of the ST **92**, the traffic visual indicator device **24** returns to the standby mode after the specified time delay.

Mode Four—the traffic visual indicator device **24** enters a mode such as this upon sensing of the critically low power storage condition. The purpose of this mode is to power conservation during the long periods of absence of charging current from the self-powering mechanism. The traffic visual indicator device **24** puts the signaling integrated circuit into shutdown mode, the microcontroller integrated circuit goes into low power mode until the power storage voltage returns above the critically low level. There can be one or more tiers of Sleep mode, each with commemorate functionality.

One or more traffic visual indicator devices **24** may also function as a slave or master to other traffic visual indicator devices **24**. By having one master traffic visual indicator devices **24** control one or more slave traffic visual indicator devices **24**, large geographic distances may be covered without use of an activation device **26**. Additionally, usage constraints may be minimized which greatly increases the commercial appeal of the system **22**. This may also used in other alternative embodiments, such as dynamic highway lighting and street lighting.

The crosswalk situation activation device **26** may include a push button, loop trigger, radar, etc, may connect with one or more activation devices **26**. This activation device **26** initiates the sensory output for the traffic visual indicator device **24** along one crosswalk. As illustrated in FIG. **12**, the activation device **26** comprise an input sensor or switch **94** such as a push button **32***a* (FIGS. **1** and **6**), proximity sensor, time of day sensor, or other internal or external sensor. The activation device **26** also comprises an activation control mechanism such as a microcontroller **96**, digital signal processor and/or application specific integrated circuit; coupled to receive signals from the input sensor or switch **94**. The activation device **26** further comprise a wireless controller PCB with a transmitter, or transceiver **98** for providing wireless communications with the traffic visual indicator devices **24**, other activation devices **26**, and/or STs **92**. The activation device **26** optionally comprises a self powering mechanism **100**, such as a photovoltaic assembly; one or more power storage devices **102** such as a primary (non-rechargeable) battery and secondary (rechargeable) battery; and/or a power regulation circuit **104** coupling the self power mechanism **100** and/or power storage device **102** to the microcontroller **96**. The power regulation circuit may be similar to that shown in FIGS. **9**A-**9**D for the traffic visual indicator devices **24**. The activation device **26** may include a housing that may be hermetically sealed. This is typically placed within close proximity to the crosswalk activation mechanism but may also be placed on a neighboring structure including a building, overhead wire, or traffic light for enhanced communications accuracy.

Components of the activation device **26** may be installed in the traffic visual indicator devices **24** for certain applications and additional embodiments.

Additional activation devices **26** may be used as repeaters for increasing the range and effectiveness of each installation and is also applicable in several other invention embodiments.

Each activation device **26** and/or traffic visual indication device **24** may act as either a master or a slave. When activated, tells the master to extend a flash cycle. The slave may waits until the end of a flash cycle to provide such information. The slave is able to track the cycle of the master. The slave is able to collect data from traffic visual indication devices **24** when the master does not receive the data, for example due to range limitations or obstacles interfering with the communications, and may then pass the information to the master for storage.

A Software Configuration Tool or ST **92** may be used for programming of the communication parameters and retrieval of the status variables stored in the traffic visual indicator devices **24** and/or activation devices **26**. The ST **92** may be housed on any standard processing device such as a laptop or personal desktop assistant (PDA) or be its own device. One or more communication sequences can be administered through the ST **92**, allowing for traffic visual indicator devices **24** to provide sequential signaling with other traffic visual indicator devices **24**.

The ST **92** allows for dynamic customizations including changes to the duty cycle, frequency, duration of primary pattern, flash duration of concluding or additional communication pattern, etc. Due to federal and state regulations, it is very advantageous to be able to change and/or modify programming of traffic visual indicator devices **24** based upon both short term and long term goals. Even after being installed in the surface, each traffic visual indicator device **24** may be fully configured remotely with the ST **92**. A means of use can enable this feature with wireless connection to Ethernet or other advanced networking transport that will allow any implementation of invention to be fully configured, monitored, and tested from the Internet or any location on the related private network.

The ST **92** offers a visual representation or simulation of the desired control parameters that can be run to give the traffic engineer or city planner (system manager) a means for gauging the effective and aesthetic parameters of any configuration prior to deploying said configuration on a traffic visual indicator device **24**. The methodology and means for developing this interface and tool are considered novel.

ST **92** provides means for preventive maintenance, with monitoring diagnostics for managing power storage levels, usage requests and implementations, pattern analysis, etc. Each ST **92** is also configurable at both a micro and macro level, allowing for two or more systems of traffic visual indicator device scenario management, as well as individual programming of traffic visual indicator devices **24**. This may be accomplished by assigning one or more management tiers to each implementation category that may be customized individually to control one or more implementations of invention.

As illustrated in FIG. **13**, the ST **92** comprises a microcontroller **106** such as a microprocessor, digital signal processor and/or application specific integrated circuit. The ST **92** may comprise an interface connector **108** such as a USB, RS232 serial interface, Ethernet to provide external communications between the microcontroller **106** and an external device. The ST **92** may also comprise a wireless signaling connector such as a transmitter and/or transceiver **110**, to provide wireless communications between the microcontroller **106** and an external device. The ST **92** may optionally comprise a power storage device **112** and power regulation circuit **114**. The power regulation circuit **114** may be similar to that illustrated in FIGS. **9**A-**9**D, or may be any conventional power regulation circuit suitable for the specific application.

Below, are described some specific applications. Other applications will be apparent from the teachings herein.

Corner Crosswalk—uses one or more traffic visual indicator devices **24** to enable flashing of devices at the corner of a street potentially interoperating with a traffic controller. This would allow pedestrians, cyclists, or traffic controller to cue signal, warning motorists by signaling surface mounted communications devices that pedestrians and/or cyclists wish to cross intersection

Transit Approach Notification—uses traffic visual indicator devices **24** that communicate with an activation device **26** located in transit vehicles **116**, including bus, train, taxi, and shuttle. At the approach of the correct transit vehicle **116**, an identifying image, light, and/or sound could be produced to notify potential passengers of the impending transit vehicle's approach, including approximate time of arrival and/or route identifier.

As shown in FIG. **14**, a transit vehicle **116** carries an activation device **26**. Transit vehicle operator may turn on the activation device **26** for providing advanced warning a transit stops **118** that the impending identified vehicle **116** is approaching within a certain measure of time that may be identified and relayed to traffic visual indicator devices **24**.

One or more traffic visual indicator devices **24** are located in such a way and/or manner that they are readily viewable to potential transit vehicle passengers. The traffic visual indicator device(s) **24** may engage potential transit vehicle passenger via optical or audio communication, relating essential information including the time until the approach of the transit vehicle, the route ID, and/or special bus features. The passengers typically wait on a sidewalk, platform or other waiting area **28** at the transit stop **118**, along side the transit surface medium such as roadway, train tracks, rail tracks, etc. 12.

Fire Hydrant Proximity Identification—uses one or more traffic visual indicator devices **24** to identify the location of water hydrants to improve ease of location for fire and/or emergency vehicles. A driver in the relating fire and/or emergency vehicle would flip a switch on a small in-vehicle transmitter that would enable surface mounted communication devices to flash and/or signal to impending vehicle within a pre-determined distance of the approach of said vehicle(s).

FIG. **15** illustrates such, showing a number of traffic visual indicator devices **24** mounted on roadway **12**, sidewalk **28***a*, **28***b*, and/or hydrant **120**.

Notification Of Speeding—uses one or more traffic visual indicator device(s) **24** to notify motorists that their speed exceeds that of the posted limit, or notifies them that their speed exceeds that of an impending corner or road hazard. traffic visual indicator device(s) **24** may either be enabled with a sensor to detect a vehicle's speed or linked to an activation device **26** that achieves this. When a driver approaches, based on speed constraints such as exceeding speed limit, exceeding safe speed for safe navigation of a corner or hazard, etc, traffic visual indicator device(s) **24** may signal to motorist with one or more optical signaling sequences and/or methodologies, allowing motorist to realize that they may need to modify their speed for their environment.

Dynamic Road Lighting—uses one or more traffic visual indicator device(s) **24** to trigger street lights base upon one or more methodologies such as with the approach of vehicles, cyclists, and/or pedestrians, by time of day, or by environmental factor such as a public or private event. For example, at the approach of a car down a roadway, traffic visual indicator device(s) **24** would activate or trigger the activation of a series of street lights that shine as the car approaches and turn to a different power state after the car leaves.

FIG. **16** illustrates such a use, showing one or more traffic visual indicator devices **24** mounted along or in transit surface **12**. Each traffic visual indicator device **24** either utilizes its own environmental sensor to identify the approach of a vehicle **16** or communicates with an activation device **26** either inside the approaching vehicle **16**, FIG. **4**, or along the vehicular path, FIG. **3**. The traffic visual indicator devices **24** may utilize any number of sensory emissions including optical and/or audio. Information may also be submitted to the traffic visual indicator devices **24** (FIGS. **1** and **6**) via periodic wireless transmissions from the activation devices **26**, to provide updated information. This same update may also be used to provide information to an traffic visual indicator device **24** in the vehicle, FIG. **4**, as it continues along the roadway, allowing it to obtain sensory information from its environment.

Lights **122** located along a road **12** may employ traffic visual indicator devices **24** to allow for wireless, dynamic communication to control lighting parameters based on the ambient conditions surrounding the lights **122**. This may include time of day programming, environmental use such as proximity congestion levels, and other preprogrammed and dynamic options that may be used for a variety of purposes including saving energy and limiting energy costs to street lights. For example, the traffic visual indicator devices **24** may adjust the amount of illumination provided by the illuminations sources **42** based at least in part on the level of light in the ambient environment. The traffic visual indicator devices **24** may additionally, or alternatively adjust the amount of illumination provided by the illuminations sources **42** based at least in part a time of day and/or year. The traffic visual indicator devices **24** may additionally, or alternatively adjust the amount of illumination provided by the illuminations sources **42** based in part on power production of the power producing source **50** and/or power reserves of the power storage device V_B.

Additional traffic visual indicator devices **24** may additionally, or alternatively, be mounted at a side of the road for wireless and dynamic communication to control parameters surrounding the road mounted traffic visual indicator devices **24**.

The road **12** may take the form of a street, highway, freeway, turnpike, bike path, train track, etc on which a moving vehicle may travel. The road **12** may have one or more traffic visual indicator device(s) **24** mounted thereto, in order to provide audio and/or optical communication and/or lighting to vehicles including pedestrians along surface.

Hazard Ahead Identification—uses one or more traffic visual indicator devices **24** to warn impending motorists, pedestrians, or cyclists of potentially hazardous changes, including raised medians, changes in the road's surface and/or the road's direction, such as curves and corners, and intersections with one or more transit type. By using wireless signaling within each device or through communication of a advanced warning notification device, each device dynamically identifies the approach of vehicles, cyclists, and/or pedestrians and displays surface mounted communication warning to them of the potential impending hazard. Similar to the example regarding notification of speed, traffic visual indicator devices **24** may contain their own sensor or be linked to an activation device **26** with a sensor that identifies the approach of a vehicle. As the vehicle approaches, optical and/or audio communication increases the perception of each motorist, pedestrian, cyclist, etc to the hazard ahead.

Icy Road Condition Beacon—uses one or more traffic visual indicator devices **24** placed on a pole, such as existing snow-depth poles, road signs, or feature specific poles at the side of or above the road to warn impending motorists of freezing temperatures and subsequently hazardous road conditions

FIG. **17** shows such a use, showing a vehicle **16** approaching an obstruction **124** such as snow and/or a snow bank where snow has been plowed.

One or more traffic visual indicator devices **24** sitting on top of a pole, sign, or other object **126** that enables improved detection by motorist. Each traffic visual indicator device **24** may include a temperature sensor that notifies impending motorist of poor road conditions. Different flash cycles and patterns, colors, and/or visual display may be used to identify one or more road conditions. For example one methodology may be used for temperatures just above freezing, another for right around freezing, one for well below freezing, and one for normal and/or safe driving conditions. In seeing the traffic visual indicator devices **24** flash one or more colors or display the temperature and or other impending road conditions, motorists may be kept aware of dynamic road conditions.

Emergency Turnout Identification—uses one or more traffic visual indicator devices **24** to identify areas in the roadway where police and/or emergency vehicles may turn-around and cross-over to opposite directions or additional roads linking freeways. Vehicles equipped with a special transmitter (activation device **26**) would flip a switch that would identify emergency turnouts along freeways, allowing them to turn around and/or cross over to the opposite side of a closed shoulder freeway.

FIG. **18** illustrates such a use, showing a road **12***a* carrying traffic in a first direction, a road **12***b* carrying traffic in the opposite direction, and a turn around road or area **12***c* connecting the roads **12***a*, **12***b*. A vehicle **16** approaches along the road **12***a*, and desires to turn around onto road **12***b*. If the vehicle is authorized to use the turn around road or area **12***c*, the vehicle may carry an activation device **26** which may employ security measures to prevent activation by unauthorized users, or which may be issued only to authorized users. Traffic visual indicator devices **24** are located along both road **12***a*, **12***b*, ways as well as at the turn around road or area **12***c*.

Roadway Exit Identification—uses one or more traffic visual indicator devices **24** to identify exits along a roadway for police, emergency vehicles, or general traffic. For emergency use, vehicles would be equipped with a small transmitter (activation device **26**) with a switch that would be flipped to identify intersecting roadways and/or turnouts. For public or commercial use, there would be a motion detector that would communicate with said surface mounted communications device, or each surface mounted communications device would detect the proximity of an approaching vehicle prior to its subsequent flashing and communication.

Shared Lane Flow Identification—uses traffic visual indicator devices **24** along roadway to identify change of shared traffic lane(s), giving transition to direction of predominant traffic based upon commute time, road hazard, dynamic traffic volume indicator, or traffic cycle. This could be used on any joined, roadway seeking to maximize flows through high volume areas, including use on bridges, carpool or special lanes, and tunnels. Surface mounted traffic visual indicator devices **24** would flash green to one traffic direction and red to the other, able to change based upon a variety of factors including time of day, day of year, or override notification from a central or remote station for change in cycle due to accident, emergency, or other temporary and permanent reason.

FIG. **19** illustrates such a use showing a road **12** comprising six lanes for traffic. Two of the lanes **130***a*, **130***b* are dedicated to traffic traveling in a first direction indicated by arrows **130**, while another two lanes are dedicated to traffic traveling in a second direction indicated by arrows **132**, generally opposed to the first direction. Finally, two lanes **134***a*, **134***b*, are reversible, allowing traffic to flow in the first or the second directions as indicated by double headed arrows **134**. The two reversible lanes have traffic visual indicator devices **24** mounted there-along. The embedded into them based on a variety of constraints such as time of day, traffic volume, accidents, etc.

Dual-sided traffic visual indicator devices **24** (e.g., FIG. **3**) are mounted in lanes **134***a*, **134***b* to provide optical emissions in order to notify motorists on the lane's proper direction or flow. For example, one side of the traffic visual indicator devices **24** may show red, with the other side green. At times when there may be a change, there could be a period of yellow before reversing to green and red, respectively. Each lane of traffic visual indicator devices **24** could be controlled individually. In this example, three lanes could be used for both directions simultaneously. For example, lanes **130***a*, **130***b*, and **134***a* in direction indicated by arrow **130**, and lanes **132***a*, **132***b*, and **134***b* in direction indicated by arrow **132**. Alternatively, four lanes could be used for travel in any one direction, with two lanes reserved for travel in the opposite direction. For example, lanes **130***a*, **130***b*, **134***a* and **134***b* for travel in the direction indicated by arrow **130** and lanes **132***a*, **132***b* for travel in the direction indicated by arrow **132**. Alternatively, lanes **132***a*, **132***b*, **134***a* and **134***b* for travel in the direction indicated by arrow **132** and lanes **130***a*, **130***b* for travel in the direction indicated by arrow **130**. Each traffic visual indicator device **24** could hold its own commands or be controlled by an activation device **26** which could either be located periodically along the roadway, or at specific locations.

FIG. **20** shows a method **200** of installing traffic visual indicator devices **24** in a road **12**, according to one illustrated embodiment.

At **202**, one or more channels or apertures are formed in the road **12**. At **204**, one or more traffic visual indicator devices **24** are mounted in the apertures formed in the road **12**. The apertures may be formed by saw-cutting, coring, or other methods. Where an anchoring mechanism **58** is employed, the anchoring mechanism **58** is first mounted to the road **12** using any variety of methods, for example a friction fit, adhesive, and/or fasteners. The housing **34** is then secured by the base **36** to the base plate **60** of the anchoring mechanism **58**. At **206**, the actuator devices **26** are installed proximate the road **12**.

FIG. **21** shows a method **300** of operating the traffic visual indicator devices **24**, according to one illustrated embodiment starting at **302**.

At **304**, the power producing source **50** produces power. At **306**, the power conversion circuitry conditions the power, for example by modifying a voltage of the power. At **308**, the circuitry determines whether power is demanded by one or more loads (e.g., illumination sources **42***a*). If no loads are demanding power, the power is stored in the power storage device V_B at **310**. If one or more loads demand power, power is supplied to the loads from the power producing source at **312**.

At **314**, the circuitry determines whether excess power is being produced. If excess power is being produced, the excess power is stored to the power storage device V_B at **310**. If excess power is not being produced, the circuitry determines whether insufficient power is being produced at **316**. If insufficient power is being produced, then power is supplied from one or more of the power storage devices V_B at **318**. The method **300** terminates at **320**.

FIG. **22** shows a method **400** of operating the traffic visual indicator devices **24** according to one illustrated embodiment starting at **402**.

At **404**, the traffic visual indicator device **24** wirelessly receives information from an external device, such as one or more of the activation devices **26**. Wireless information may be received via radio frequency transmissions or via light transmissions, such as via infrared transmissions. At **406**, each of the traffic visual indicator device **24** determines whether the wireless information is addressed to the particular traffic visual indicator device **24** receiving the wireless information, for example by determining whether the information includes a unique identifier that identifies the particular traffic visual indicator device **24**.

If the wireless information is not addressed to the particular traffic visual indicator device **24**, the traffic visual indicator device **24** may optionally wirelessly retransmit the received information at **408**, and terminate the method **400** at **410**. Otherwise, control passes to **412**.

Optionally at **412**, one or more sensors determine a condition of the ambient environment. Optional conditions may include precipitation, temperature, pressure, light levels, seismic, visual or acoustical information. Optionally, the traffic visual indicator device **24** wirelessly transmits the information regarding the ambient condition at **414**.

At **416**, the traffic visual indicator device **24** processes the received information, and optionally the ambient condition information. At **418**, the traffic visual indicator device **24** activates the illuminations sources **42***a* based at least in part on the received information to transmit a visual signal toward approaching traffic. The traffic visual indicator device **24** may also base the activation of the illuminations sources **42***a* at least in part on the ambient conditions. For example, the traffic visual indicator device **24** may adjust an intensity of the light based on ambient light conditions, or may adjust the volume of sound based on ambient noise conditions.

FIG. **23** shows a method **500** of operating a traffic information system **22** according to one illustrated embodiment starting at **502**.

At **504**, a portion of the traffic information system **22**, for example the traffic visual indicator device **24**, senses the approach of a vehicle such as a public transit vehicle or taxi. At **506**, the traffic information system **22** determines an approximate arrival time for the vehicle. Optionally, at **508**, the traffic information system **22** determines a route of the vehicle. At **510**, the traffic visual indicator devices **24** produce visual indications of the arrival time and/or route of the vehicle. The method **500** terminates at **512**.

FIG. **24** shows a method **600** of operating the traffic information system **22** starting at **602**.

At **604**, a portion of the traffic information system **22**, for example the traffic visual indicator devices **24**, senses the speed of one or more approaching vehicles. At **606**, a portion of the traffic information system **22**, for example the traffic visual indicator device **24**, optionally compares the sensed speed with a posted speed. At **608**, the traffic information system **22** optionally determines whether the sensed speed is above the posted speed. If the sensed speed is above the posted speed, at **610**, the traffic visual indicator devices **24** activate the illuminations sources **42***a* to produce a visual warning to the approaching traffic. Alternatively, the traffic visual indicator devices **24** may activate the illuminations sources **42***a* to produce a visual warning to the approaching traffic without regard to whether the sensed speed in above or below the posted speed. The method **600** terminates at **612**.

FIG. **25** shows a method **700** of operating an activation device **26** according to one illustrated embodiment, started at **702**.

At **704**, the activation device determines whether an activation has been received. For example, activation device determines whether a pedestrian has pushed a button, or whether a proximity sensor has detected an object or motion.

If activation is received, the activation device **26** wirelessly transmits information to the traffic visual indicator devices **24** at **706**. At **708**, the activation devices **26** optionally wirelessly transmit information to other activation devices **26** and the method **700** terminates at **710**.

If an activation is not received at **704**, then the activation device **26** determines whether information has been wirelessly received at **712**. Optionally at **714**, the activation device **26** may wirelessly retransmit received information to other activation devices **26**.

Airport Traffic Flow—uses traffic visual indicator devices **24** on airport runways and on airport tarmacs for vehicular flow assistance. Rather than wiring lights, surface mounted communications devices would identify transit patterns for planes and airport vehicles. With a small wireless transmitter or controller in vehicles, lighting colors and impending permissions would change, giving right-of-way and navigational guidelines.

Children/Elderly/Handicap Present Notification—uses one or more is traffic visual indicator devices **24** along roadway and/or sidewalk to warn motorists that children, the elderly, and/or handicapped individuals are present. These traffic visual indicator devices **24** would be used in front of a school during opening and closing, at or near a playground and park, in front of a retirement home, etc); each would be pre-programmed by time of day and day of year or by the approach of vehicle, bicyclist, or pedestrian.

Vehicle Exit/Approach Warning—uses one or more traffic visual indicator devices **24** to warn pedestrians crossing in front of where the exit of a parking garage enters the street, that a vehicle is emerging from a parking garage. This would also include warning pedestrians, cyclists, and motorists that an emergency vehicle, such as a fire, ambulance, paramedic, or service vehicle is leaving/approaching a fire station, hospital, etc or traveling a path that would benefit by dynamic roadway lighting such as a service or emergency vehicle in a concentrated pedestrian area. There would be an auto sensor in each surface mounted traffic visual indicator device **24** or a sensor that would communicate with each traffic visual indicator device **24** in the example of the parking garage or related application and structure, while there could be a switch with a small wireless controller in each emergency vehicle or a controller with related switch in each related building that a person would use prior to leaving/approaching said related locality.

Pre-empter Trigger—uses one or more traffic visual indicator devices **24** to receive communication from a traffic controller at the approach of an on-call emergency vehicle using a pre-empter to proceed through a traffic signal. Currently emergency vehicles use audio signaling which oftentimes does not identify their locality or proximity. By tying communication to surface mounted traffic visual indicator devices **24** to a controller inserted into an existing traffic controller and placing said devices along roadway, sidewalks, and along the sides of buildings and/or traffic signs and roadway poles, pedestrians and motorists may see that an impending emergency vehicle approaches them, and the direction with which it comes. This would allow them to move over to the side of the roadway, possibly saving the emergency vehicle time getting through the intersection, which could possibly save lives and/or property.

National/Local Emergency Notification—uses one or more traffic visual indicator devices **24** to inform pedestrians, motorists, and the general public about a state of emergency or issue of national importance. Similar to the Emergency Broadcast Network found on both television and radio, this would enable the government to convey a message to the mass population who are in urban centers and along the roadway. While a particular color could be used, devices could also issue a pre-recorded or real-time audio message, as well as be used to project an image, picture, or video along a wall, sign, or building.

Crosswalk Time Notification—uses one or more traffic visual indicator devices **24** to warn pedestrians of the amount of time left before the crosswalk signal ends. This could be used in conjunction with surface mounted communications lighting or independently to provide audio notification of the time left on a crosswalk signal or for notification that it is okay to cross the roadway. Each traffic visual indicator device **24** would be used in conjunction with a signaling transmitter, which could be placed inside each said device or used in conjunction with another device, including a push-button or bollard with wireless detector.

Crosswalk Directional Navigation—uses one or more traffic visual indicator devices **24** to assist vision impaired pedestrians navigate across a crosswalk or intersection through audio emissions

Instruction Device—uses one or more surface mounted traffic visual indicator devices **24** to provide instructions to people at locations of public and private interest such as historical spots, museums, parks, zoos, public buildings, etc. At the approach of a person or by pushing an activation device such as a button, or by stepping on the surface mounted communications device, a pre-recorded or real-time audio message may be played.

Handicapped Hazard Notification—uses one or more traffic visual indicator devices **24** to auto-sense the approach of handicapped pedestrians and warn of curb, door, wall, stairs, etc.

National/Local Emergency Notification—similar to above, uses one or more traffic visual indicator devices **24** to deliver audio messages and/or real-time dialogue to pedestrians and/or general public regarding information of local, regional, or national concern

Corridor Traffic Counter—uses one or more traffic visual indicator devices **24** to identify traffic volumes along any given lane (place several to determine volumes along any given roadway). This may be via one or more sensory methodologies such as magnetic or infrared detection.

Navigation Identification—uses one or more traffic visual indicator devices **24** to record movement and location, and/or transit pattern of tagged vehicles, people, or animals, for use in closed environments such as prisons, military bases, or corporate campuses or for open environments of public vehicles along roadways, or persons in cities or buildings.

Environmental Identification—uses one or more traffic visual indicator devices **24** to record and/or send temperature and/or other environmental details such as humidity, or composition of air quality of geographic locality to remote location or store internally for remote uplink

Seismic Transponder—uses one or more traffic visual indicator devices **24** to sense seismic activity along a surface area, to record, triangulate, and/or store and transmit related data. By having sensors along the stem of each traffic visual indicator devices **24**, they may record geographic forces such as earth movements and other geographic shocks. This information may be recorded and stored or sent.

Stoplight Trigger—uses one or more traffic visual indicator devices **24** to sense the approach of a vehicle through either magnetic or motion detection, such as radar, infrared or an optical sensor. Rather than digging up roadway to install and wire a magnetic sensor, traffic visual indicator device **24** may be used to wirelessly transmit the approach of a vehicle to the traffic control box, resulting in the appropriate change of the stoplight lighting signal.

FIG. **26** shows an overall state machine **800** implementing the traffic information system **22**, according to one illustrated embodiment. The states include: polling **802**, parsing an activation message **804**, parsing a configurator message **806**, and activated **808**, with acceptable transitions between the states defined by the arrows.

FIG. **27** shows a state machine implementing the polling state **802** (FIG. **26**) in the traffic information system, according to one illustrated embodiment. The states include a sleeping state **810** and a listening state **812**, with acceptable transitions between the states defined by the arrows.

FIG. **28** shows a state machine implementing the parsing an activation message state **804** (FIG. **26**), according to one illustrated embodiment. The states include parsing the message **814**, with acceptable transitions into an out of the state defined by the arrows.

FIG. **29** shows a state machine implementing the parsing an configurator message **806** (FIG. **26**), according to one illustrated embodiment. The states include password checking **816** and parsing of the message **818**, with acceptable transitions between the states defined by the arrows.

FIG. **30** shows a state machine implementing the activated state **808** (FIG. **26**), according to one illustrated embodiment. The states include an activated state **820** and a listening for additional activation state **822**, with acceptable transitions between the states defined by the arrows.

FIG. **32** shows an overall state machine **900** implementing the functionality of a master activation device **26** of a traffic information system **22**, according to one illustrated embodiment. The states include a polling state **902**, an RTC (i.e., real time clock) interrupt state **904**, a parsing configurator message state **906**, and an activated state **908**, with acceptable transitions between the states defined by the arrows.

FIG. **33** shows a state machine implementing the polling state **902** (FIG. **32**), according to one illustrated embodiment. The states include a sleeping state **910** and a listening state **912**, with acceptable transitions between the states defined by the arrows.

FIG. **34** shows a state machine implementing the RTC interrupt state **904** (FIG. **32**), according to one illustrated embodiment. The states include a process interrupt state **914**, a Request information from RS (i.e., traffic visual information device) number x state **916**, and an ask slave AT (i.e., activation device **26**) to request/relay information state **918**, with acceptable transitions between the states defined by the arrows.

FIG. **35** is a schematic diagram of a state machine implementing the parse configurator message state **906** of the state machine of FIG. **32**, according to one illustrated embodiment. The states include a password check state **920** and a parse SC (e.g., a small PC adapter that manages the configuration software) message state **922**, with acceptable transitions between the states defined by the arrows.

FIG. **36** shows a state machine implementing the activated state **908** (FIG. **32**), according to one illustrated embodiment. The states include a wake up RSs state **924**, a synchronization state **926**, and a listen for slave activation device reactivation state **928**, with acceptable transitions between the states defined by the arrows.

FIG. **37** shows an overall state machine **930** implementing the functionality of a slave activation device **26** of a traffic information system **22**, according to one illustrated embodiment. The states include a polling state **932**, a relay RS information state **934**, an activated state **936**, and a parse configurator message state **938**, with acceptable transitions between the states defined by the arrows.

FIG. **38** shows a state machine implementing the polling state **932** (FIG. **37**), according to one illustrated embodiment. The states include a sleeping state **940** and a listening state **942**, with acceptable transitions between the states defined by the arrows.

FIG. **39** shows a state machine implementing the relay RS (i.e., traffic visual information device **24**) information state **934** (FIG. **37**), according to one illustrated embodiment. The states include a wake up RS state **944** and a request information from RS state **946**, with acceptable transitions between the states defined by the arrows.

FIG. **40** shows a state machine implementing the activated state **936** (FIG. **37**), according to one illustrated embodiment. The states include an activated state **948** and a send reactivation to master state **950**, with acceptable transitions between the states defined by the arrows.

FIG. **41** shows a state machine implementing the parse configurator message state **938** (FIG. **37**), according to one illustrated embodiment. The states include a password check state **952** and a parse SC message state **954**, with acceptable transitions between the states defined by the arrows.

The present disclosure discusses a wide variety of methods and devices for controlling and monitoring limited power while performing one or more forms of communication. These includes: 1) one-way energy valve diode; 2) directional current sensor; 3) frequency shift keying; 4) threshold controls; 5) energy valve diode; 6) communication modulation; 7) switching system; 8) packet minimization; 9) individual addressing of each traffic visual indicator device **24**; 10) channel differentiation; 11) staggered output signaling; 12) sensory filter; 13) sensor management; 14) frequency hopping; 15) sensor control; 16) slave and master; and 17) visual implementation demonstration.

It includes a wide-variety of physical forms and alternative embodiments that rely on the present invention's ability to perform multiple calculations, sensory responses and actions, and data capture and dynamic transmission within a tight window of technical feasibility.

These alternative embodiments are also novel and unique, in both form and function and include:

(1) Advanced Warnings—Activated by such means as inroad (loop) detectors or radar, inroad lights can warn motorists of impending stops and stoplights, dangerous turns and other road hazards, railroad crossings, or intersections.

(2) Unsignalized Crosswalk Lighting—With the push of a button or other activation mechanism, pedestrians can activate inroad lights to alert motorists to their presence in the crosswalk.

(3) Feature Locators—Activated by the approach of a fire truck or other vehicle, inroad lights identify such things as fire hydrants, minimizing the time to locate them and potentially saving millions of dollars of potential devastation. They may also be used to identify road turnouts, roundabout, traffic circles, and apron markings for things like buses and taxis.

(4) Shared Lane—By placing on roadways with high directional commuter traffic, lanes may be switched from one direction to another by time of day or other dynamic circumstances. Additionally, lanes may be changed for an emergency or for environmental circumstances such as the start/release of a sporting event or concert.

The above description of illustrated embodiments, including what is described in the Abstract, is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Although specific embodiments of and examples are described herein for illustrative purposes, various equivalent modifications can be made without departing from the spirit and scope, as will be recognized by those skilled in the relevant art. The teachings provided herein can be applied to other signaling device, not necessarily the exemplary traffic visual indicator devices **24** and traffic information system **22** generally described above.

For instance, the foregoing detailed description has set forth various embodiments of the devices and/or processes via the use of block diagrams, schematics, and examples. Insofar as such block diagrams, schematics, and examples contain one or more functions and/or operations, it will be understood by those skilled in the art that each function and/or operation within such block diagrams, flowcharts, or examples can be implemented, individually and/or collectively, by a wide range of hardware, software, firmware, or virtually any combination thereof. In one embodiment, the present subject matter may be implemented via Application Specific Integrated Circuits (ASICs). However, those skilled in the art will recognize that the embodiments disclosed herein, in whole or in part, can be equivalently implemented in standard integrated circuits, as one or more computer programs running on one or more computers (e.g., as one or more programs running on one or more computer systems), as one or more programs running on one or more controllers (e.g., microcontrollers) as one or more programs running on one or more processors (e.g., microprocessors), as firmware, or as virtually any combination thereof, and that designing the circuitry and/or writing the code for the software and or firmware would be well within the skill of one of ordinary skill in the art in light of this disclosure.

In addition, those skilled in the art will appreciate that the mechanisms of taught herein are capable of being distributed as a program product in a variety of forms, and that an illustrative embodiment applies equally regardless of the particular type of signal bearing media used to actually carry out the distribution. Examples of signal bearing media include, but are not limited to, the following: recordable type media such as floppy disks, hard disk drives, CD ROMs, digital tape, and computer memory; and transmission type media such as digital and analog communication links using TDM or IP based communication links (e.g., packet links).

The various embodiments described above can be combined to provide further embodiments. All of the U.S. patents, U.S. patent application publications, U.S. patent applications, foreign patents, foreign patent applications and non-patent publications referred to in this specification and/or listed in the Application Data Sheet, including but not limited to U.S. provisional patent application Ser. No. 60/544,138, filed Feb. 13, 2004, and entitled Self-powered In-Surface Communications Device, are incorporated herein by reference, in their entirety. Aspects of the invention can be modified, if necessary, to employ systems, circuits and concepts of the various patents, applications and publications to provide yet further embodiments of the invention.

These and other changes can be made to the invention in light of the above-detailed description. In general, in the following claims, the terms used should not be construed to limit the invention to the specific embodiments disclosed in the specification and the claims, but should be construed to include all methods, systems and devices that operated in accordance with the claims. Accordingly, the invention is not limited by the disclosure, but instead its scope is to be determined entirely by the following claims.

The invention claimed is:

1. A traffic display network comprising:

a plurality of remotely-programmable traffic control devices each having an externally-visible display capable of generating at least one signal to oncoming traffic;

a communications system capable of communicating remote programming instructions to the plurality of remotely-programmable traffic control devices; and

a storage storing a list of network addresses of the remotely-programmable traffic control devices included in the traffic display network,

the traffic display network uses the list of network addresses to automatically coordinate at least one timing parameter of the remotely-programmable traffic control devices.

2. The traffic display network of claim **1**, the display network being configured to alternate between a plurality of modes.

3. The traffic display network of claim **2**, the plurality of modes including at least one of the modes selected from the group consisting of a passive mode, an active mode, a service mode, a sleep mode, a testing mode, and a servicing mode.

4. The traffic display network of claim **1**, the communication system being capable of coordinating the operations of the plurality of the remotely-programmable traffic control devices.

5. The traffic display network of claim **1** where the control system is configured to set at least one of the plurality of the remotely-programmable traffic control devices to a one of a plurality of traffic signals.

6. The traffic display network of claim **1** wherein the remotely-programmable traffic control devices further comprise a power producing source capable of generating power for operation of the remotely-programmable traffic control device.

7. The traffic display network of claim **1**:

wherein the remotely-programmable traffic control devices further comprise a control system being capable of being remotely programmed, where the communications system is capable of communicating to the control system programming instructions received through Internet.

8. The traffic display network of claim **1**, further configured so that a wireless network communicates the programming instructions from the Internet to the traffic display network.

9. The traffic display network of claim **8** where the communications system is further capable of uploading data to the wireless network.

10. The traffic display network of claim **1** where the communications system is capable of communicating data to the Internet.

11. The traffic display network of claim **6** where the power producing source comprises at least one solar panel.

12. The traffic display network of claim **1** where the communication system is configured to receive signals from the at least one remotely-programmable traffic control device.

13. The traffic display network of claim **1** where the communication system operates continuously.

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